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COVER IMAGE

The present Brazilian Astrophysics Laboratory atop Pico dos Dias in southern Brazil, at an altitude of nearly 2,000 m. Inaugurated in 1981 under its original name as the Brazilian Astrophysics Observatory, it was the culmination of over half a century of astronomical development in the country. It is now home to a 1.6-m Perkin-Elmer and a 1.0-m Zeiss telescope. To learn more about the history of twentieth-century astronomy in Brazil, read the research paper by Cristina de Amorim Machado and Antonio A.P. Videira, starting on page 223.

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A MOUNTAIN OBSERVATORY AND THE BRAZILIAN ASTROPHYSICS PROJECT

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Abstract: The Brazilian astrophysics project is intimately linked to a scientific institution that came into existence in the 1980s: the National Astrophysics Laboratory. Responsible for enabling the development of Brazilian research in this area, its history dates back to a dream to build an observatory on a mountaintop conceived at an institution formed in the nineteenth century, the Imperial Observatory of Rio de Janeiro, later the National Observatory. It is a story of national and international scientific cooperation, especially in the second half of the twentieth century. This paper tells the story of this dream and how it was transformed into reality in the 1980s with the installation of what was then called the Brazilian Astrophysics Observatory, heralding a new era for astronomical research in Brazil.

Keywords: mountain observatory, Brazilian Astrophysics Project, National Observatory, Brazilian Astrophysics Observatory, Brazilian Astrophysics Laboratory.

1 INTRODUCTION

The National Astrophysics Laboratory (Laboratório Nacional de Astrofísica), the first of its kind in Brazil, is the current name (as of 1985) for what was originally the Brazilian Astrophysics Observatory (Observatório Astrofísico Brasileiro). It was formerly part of the National Observatory (Observatório Nacional), which in 1980 acquired a large-scale instrument (for the time), a 1.60-m Perkin-Elmer telescope, through the combined efforts of a number of individuals.

What we intend to show in this paper is that the institutionalization of astrophysics in Brazil as a field of knowledge only began as Brazilian astronomy developed. This resulted in the construction of the Brazilian Astrophysics Observatory and the installation of what is to this day the largest telescope on Brazilian soil—in other words, the creation and equipping of a scientific institution. This trajectory began with an apparent pipe dream to build an astrophysical observatory in Brazil, passed through the planning of the development of Brazilian astronomy in the 1960s, and the collaborative efforts in that and the following decade to have a large telescope installed in the country, and ultimately led to the observatory's actual establishment in 1980.

Obviously, none of this would have been possible without the people who

1) wanted to build an astrophysical observatory to leverage astronomical research in Brazil;
2) crafted concrete plans from this dream;
3) executed these plans until the dream became a reality;
4) have maintained this reality for the last three decades; and
5) have worked hard to ensure this reality keeps up with transformations in Brazilian and international science.

Clearly, everyone who currently works at the headquarters of the National Astrophysics Laboratory in Itajubá (see Figure 1 for Brazilian locations mentioned in the text) and the observatories under its management is part of this story and is building the present-day history of this institution. But there are some recent retirees or people soon to retire who represent not only the institution's memory but also its present. There also are others who have passed away but who documented this journey in the most diverse of ways. They include a few generations of technicians, engineers, physicists, astronomers, and, more recently, astrophysicists, who have shaped and continue to shape the political and scientific nature of astrophysics in Brazil.

These are the protagonists of this story—key sources we have consulted through interviews, informal conversations, and documents of different kinds, ranging from letters, telegrams and other texts stored in the history of science archives at the Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins) to a wide range of research papers, research journals, books, contracts, project reports, photographs and various other images, and documents, housed in the archives of the National Astrophysics Laboratory.

Figure 1: Brazilian localities mentioned in the text.

It is already clear that this is the history of an institution in transformation in a country in transformation, and that it took shape through national and international scientific cooperation—even when it was no more than a dream—and was led by people with vision and the staying power to see this dream through to reality.[1]

2 OF DREAMS AND DREAMERS

Domingos Fernandes da Costa (1882–1956; Figure 2),[2] or 'Commander Costa', as he was known at the National Observatory, being as he was an officer in the Brazilian Navy, joined the National Observatory in 1909, when it was still based on Morro do Castelo in the center of Rio de Janeiro. He continued to work there even after he retired (1954) right up to his death. He enjoyed supervising students at the beginning of their scientific careers, and left behind many admirers.

For the purposes of this story, it is important to note that Costa was the person who devised the plans for the 'mountain observatory' that the National Observatory's Director, Sodré da Gama, submitted to the Minister of Education, Gustavo Capanema (1900–1985), and President Getúlio Vargas (1882–1954) in 1936. However, the execution of these plans was thwarted by WWII. According to Lélio Gama (1977: 12)—no relation to Sodré da Gama—"Domingos Costa put together the project to build a regional astrophysics observatory …" on Serra da Bocaina. He adds that the scientific equipment was chosen by Costa after discussions with an expert

from Carl Zeiss (the German company working in the optics and optoelectronics industries), but the company withdrew from the project after the outbreak of war in 1939.

According to Luiz Muniz Barreto (1987: 201–202), Costa proposed a complete overhaul of the National Observatory during the Sodré da Gama's directorship, which was to include installing a 'mountain observatory'. The site chosen for this was Serra da Bocaina, but as already explained the war frustrated Costa's plans and delayed the whole process. He was also well aware of the need to have people trained in astrophysics to operate the future observatory, despite Barreto's (1987: 291) later claim that: "We can learn that afterwards, because we'll do it already as astronomers of the National Observatory." Years later, in 1955, the National Observatory, which was then directed by Lélio Gama, was enjoying a period of prosperity and the dream of building a mountain observatory had been all but forgotten. Although Costa still wanted to put it back on the agenda, he thought that first they should

> … organize the lines of work the observatory was prepared for … [and] develop the two points missing in the area of geophysics: seismology and gravimetry. (Barreto, 1987: 292).[3]

Costa died in 1956 without seeing his plans come to fruition, but his pupil, Barreto, and others revived them in the early 1960s. However, before we go into this 'revival', let us first meet Sodré da Gama, the Director of the National Observatory at the time that 'Commander Costa' had his dream of a mountain observatory.

Sebastião Sodré da Gama (1883–1951; Figure 3) had a degree in mathematics and taught at the Polytechnic School (Escola Politécnica) and two high schools in Rio de Janeiro. Amongst his many achievements, what interests us here is his submission in 1936 to the Federal Government of Costa's proposal for the construction of an astrophysics observatory on Serra da Bocaina, his 'mountain observatory', and its subsequent approval. As we mentioned earlier, to take the project forward, Gama even ordered some instruments from Carl Zeiss, but with the outbreak of WWII the observatory ended up not being built. However, Gama did manage to get some of Costa's objectives included in the National Observatory's bylaws of 1940, namely, to develop astrophysics and international astronomical cooperation, and have a mountain observatory—yet to be built—as part of its facilities:

> Art.1. The objective of the National Observatory ... is: a) to conduct research in astronomy, geodesy, geophysics, and astrophysics; b) to execute programs of astronomical, magnetic, seismological, and gravimetric observations in order to contribute to the cultural development of the country and cooperate with foreign observatories for the development of science, especially in areas that may be of interest to Brazil; ... Art.3. The National Observatory shall be constituted of the following divisions: ... b) division of equatorial and related services, whose activities shall be conducted at two observatories, one of which is installed in the Federal District, and the other of which is to be installed on a mountain. (Ministério da Educação e Saúde, 1940: 3).

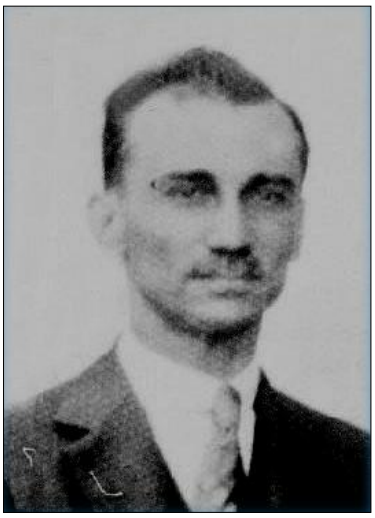


Figure 2: Domingos da Costa (courtesy: www.on.br).

Years later, one of Costa's former colleagues, Lélio Gama, in his role as Director of the National Observatory, gave him *carte blanche* to resume the scientific cooperation project in collaboration with Muniz Barreto, which envisaged, amongst other things, the creation of an astrophysical observatory. However, in at least two letters, one written to Antonio Couceiro in 1961, and the other to Abrahão de Moraes in 1964, Gama (1961; 1964) expresses some reservations because of the formative state of Brazilian

Figure 3: Sodré da Gama (courtesy: www.on.br).

Figure 4: Lélio Gama (courtesy: www.on. br).

astronomy at the time and level of training of the astronomers.

Lélio Gama (1892–1981; Figure 4) studied at the Polytechnic School of Rio de Janeiro, where he earned degrees in geographical engineering (1914) and civil engineering (1918). He lectured at the same institution, and also at the School of Science of the University of the Federal District (Universidade do Distrito Federal) and the University of Brazil (Universidade do Brasil). Outside academia, Gama was a key player in the founding of new scientific institutions, including the National Council for Science and Technology Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico) and the Institute of Pure and Applied Mathematics (Instituto de Matemática Pura e Aplicada).

Gama's career at the National Observatory began in 1917, when he was employed as an interim Calculator. In 1919 he was deployed on a scientific expedition that observed the total solar eclipse and confirmed Albert Einstein's General Theory of Relativity (Videira, 2007). Two years later he was officially employed as a Calculator, and also appointed Assistant Astronomer. He became an Astronomer of the National Observatory in 1937, where he headed the Meridian Services Division from 1946 to 1951. He was appointed Director of the Observatory in 1952, serving until 1967, during which time, together with Abrahão de Moraes, Director of the Institute of Astronomy and Geophysics at the University of São Paulo (Instituto de Astronomia e Geofísica da Universidade de São Paulo), he set up an historic partnership that effectively laid the groundwork for the Brazilian astrophysics project.

Figure 5: Abrahão de Moraes (courtesy: www.on.br).

In 1967, when Gama reached retirement age, Barreto took over as Director of the National Observatory, where he continued the scientific cooperation with the Institute of Astronomy and Geophysics initiated by his predecessor and Moraes in 1957. So let us find out a little more about Moraes.

Abrahão de Moraes (1917–1970; Figure 5) earned his degree in physics in 1938 from the Faculty of Philosophy, Science and Letters of the University of São Paulo. In 1945 he earned the titles of Professor and Doctor of Science from the Polytechnic School. He lectured in rational mechanics, analytical mechanics, celestial mechanics and mathematical physics at the University of São Paulo. In 1949 he took over as Head of the Department of Physics, and in the same year was involved in founding the Association of Amateur Astronomers of São Paulo. In 1955 he was selected to run the Institute of Astronomy and Geophysics at the University, a position he held until the end of his life.

Well known for his interest in astronomy, Moraes was invited to write the chapter on "Astronomy in Brazil" for Fernando de Azevedo's book, *Science in Brazil* , first published in 1955. Considered a classic text on the history of Brazilian astronomy, the writing of this chapter offered Moraes a broad perspective on the nation's astronomy, which he believed could only prosper if an observatory was built in a suitable region and through scientific cooperation. Moraes (1955: 160) writes:

> For our country to be able to cooperate effectively for the progress of astronomy, an observatory must be erected or an existing one must be transferred to a region whose climate is more propitious, far from the big cities. There is also a need to attract to our circle some very capable astronomers and send our young people interested in studying astronomy to leading European and American establishments. A similar procedure employed in other scientific domains has already yielded very commendable results.

According to Walter Maciel, one such young astrophysicist, Moraes, was the "… father of Braz-

ilian astrophysics …", even though he never was a research astronomer:

> He was the one who had the vision to get together some promising young students and send them to France to do their doctorates. The students came back and started to plant the seeds. The seeds are here. (Maciel, 2004: 140).

Amongst his many scientific, teaching and administrative duties, Moraes was responsible for arranging the activities at the Institute of Astronomy and Geophysics during the International Geophysical Year (Videira et al., 2002); coordinating the recording of Sputnik I and Explorer I as they passed over Brazil; boosting investments in the institute's library; and—together with Jean Delhaye (whom we introduce below)—preparing a plan to obtain instruments for astronomical work.

In "The Development of Astronomy in Brazil" Moraes (1961a) describes the state of Brazilian astronomy at the time and what it needed to develop further, including a budget for the program to install the Brazilian Astrophysics Observatory.[4] Besides discussing the choice of site and acquisition of equipment, the document also states that the training and retention of personnel were a priority, and that all this should be pursued in the context of national and international cooperation. Moraes also successfully applied to have Brazil readmitted to the International Astronomical Union at its 11th General Assembly, in Berkeley, USA, in August 1961.

In 1964 Moraes and Barreto formally initiated the partnership between the National Observatory and the Institute of Astronomy and Geophysics with a view to installing an astrophysical observatory (Barreto, 1987), an initiative that also counted on the assistance of a commission which included three French astronomers. Tasks were distributed as follows: the Institute was responsible for orienting and training technical staff and researchers, while the National Observatory would choose the site and acquire the instruments. Initially Barreto was in charge of selecting the site, and he took over the project after Moraes' death and saw it through to completion, becoming one of the key people responsible for making the Brazilian Astrophysics Observatory a reality. Let us therefore investigate this important individual in more depth.

Luiz Muniz Barreto (1925–2006; Figure 6), or the 'Man from the Moon', as Israel Pinheiro (Governor of the State of Minas Gerais from 1966 to 1971) called him, joined the National Observatory in 1945 as an intern. He went on to serve as its Director for two separate periods, 1968–1979 and 1982–1985. He earned a degree in civil and electrical engineering in 1949 from the National School of Engineering (Escola Nacional de Engenharia) and a degree in physics from the Faculty of Philosophy, Science and Letters of the State University of Guanabara (now the State University of Rio de Janeiro) in 1959. He earned a D.Sc. in rational mechanics and celestial mechanics in 1962, and the following year became a Professor of General Mechanics at the University of Guanabara. He worked at several universities in Brazil and other countries, including the State University of Rio de Janeiro, where he was Dean for Graduate Education and Research (1981). He was also a member of scientific societies, including the Astronomical Society of France and the International Astronomical Union. He was responsible for forming important research groups at the National Observatory, the Technological Institute

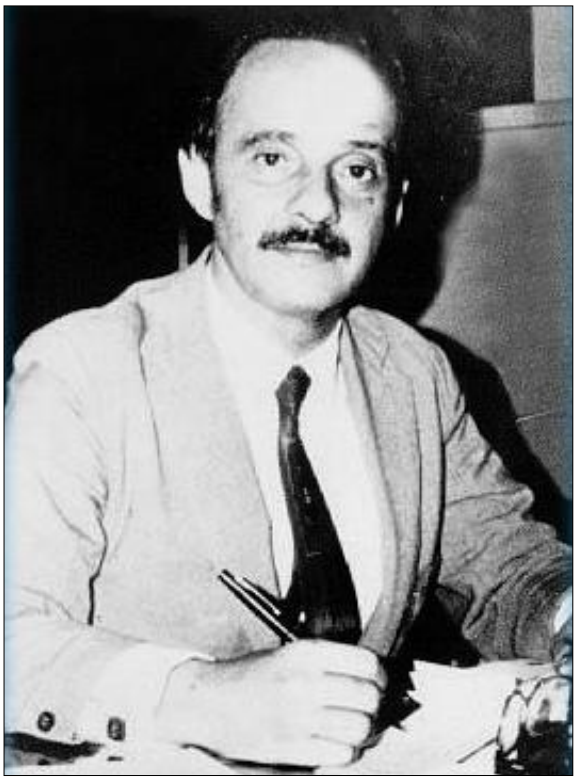


Figure 6: Luiz Muniz Barreto (courtesy: www.on.br).

of Aeronautics (Instituto Tecnológico de Aeronáutica) and the Federal University of Minas Gerais.

What most interests us here is this last-mentioned activity, in view of the three action lines he reported on in the "Project for the Development of Astronomy in Brazil" (Barreto, 1976), namely the training of personnel, the acquisition of instruments and the choice of site for the new astrophysical observatory. All this was part of his proposal for the reformulation of the National Observatory submitted during Lélio Gama's administration. As well as these three areas, Barreto stressed the need to establish national and international scientific cooperation, and started taking measures to bring this about.

In his 1976 report, Barreto describes step-by-step everything that had been done up to that point for the establishment of a 'mountain observatory'. This includes his leadership in the acquisition of the telescope and in developing the associated support structure during the 1960s and 1970s, such as the training of specialized personnel and the actual installation of the Brazilian Astrophysics Observatory (now the National Astrophysics Laboratory). The new Observatory was responsible for raising astronomical research in Brazil to a new level, with the production of a great quantity of data used in countless scientific studies at an international level, and it also provided research opportunities for Masters and Doctoral students both inside and outside of the National Observatory (see Maciel, 1996; Steiner, 2009). We can say that much of this happened thanks to the 'Man from the Moon'.

3 MULTI-INSTITUTIONAL COOPERATION AND PREPARATIONS FOR THE BRAZILIAN ASTROPHYSICS OBSERVATORY

As we saw, Muniz Barreto spearheaded the project to develop Brazilian astronomy in the 1960s and 1970s. However, this would not have been possible without scientific cooperation, which first was established between the National Observatory and Institute of Astronomy and Geophysics (Barreto, 1976). We also have seen that Abrahão de Moraes was the mentor of the plan to develop astronomy in Brazil, which he discussed at length with French colleagues. Three of them, plus some Brazilians, set up the Rösch Commission under the auspices of the International Astronomical Union,[5] and in 1964 the French astronomers came to Brazil to help choose the site for the Brazilian Astrophysics Observatory. In addition, they were directly or indirectly involved in training some of the protagonists of this story, giving courses in Brazil and supervising young Brazilian doctoral candidates back in France.

The three French astronomers, Jean Delhaye (1921–2001), Jean Rösch (1915–1999) and Roger Cayrel (b. 1925), at the time were Director of the Besançon Observatory, Director of the Pic du Midi Observatory, and Head of Astrophysics at the Paris Observatory, respectively. As members of the Rösch Commission, it was they who would kick-start the work to choose an appropriate site for the long-awaited Brazilian Astrophysics Observatory. They based their discussions around the plan for the development of astronomy in Brazil, itself inspired by the Moraes' (1961a) document.

The task of selecting a site for the Observatory—assigned to the National Observatory—was, Delhaye acknowledged, a slow process, but he explains that this was because the selection criteria for a site for this type of observatory were stricter than those for an astrometric observatory. Commenting on the final choice, the installation of the telescope, and its first users, the French astronomer said:

> Many sites were studied, of which Pico dos Dias (1860m) was chosen [see Figure 7], near Itajubá (Minas Gerais), where a 1.60m diameter telescope was first installed, which was inaugurated in 1981, almost 20 years after the beginning of the aforementioned collaboration. The first users of this telescope were trained throughout this lengthy period, and were the young doctors that had studied abroad and who, at this stage, had already constituted education of quality in Brazil. (Delhaye, 1994: 16).

Figure 7: Pico dos Dias, before the observatory was constructed (courtesy: National Astrophysics Laboratory Archive).

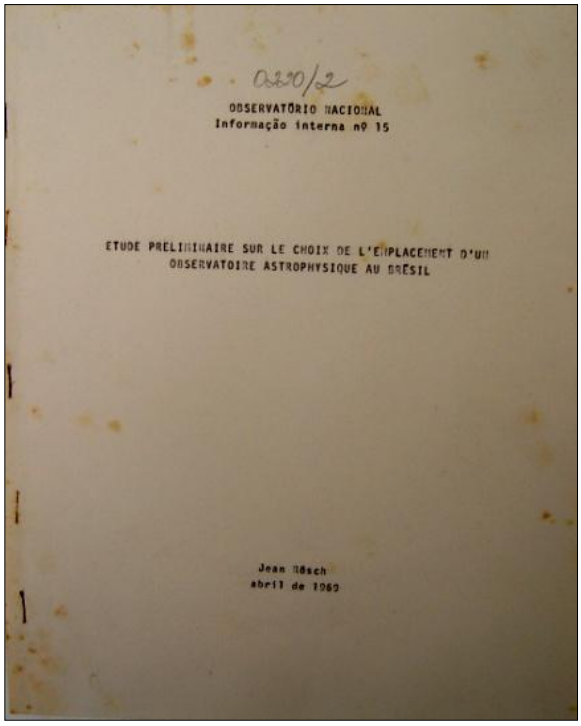
Delhaye (1994: 16) comments on what a pleasure it was to have been Abrahão de Moraes' main partner on this program, because he had the chance to take part in an exciting, rewarding enterprise. Furthermore, "The success of this undertaking must be credited to its instigator, his first students, and those who took it forward."

Jean Rösch chaired the Rösch Commission, which also undertook the first discussions about the plan for the development of astronomy in Brazil. He also was responsible for a report, *Preliminary Report on the Choice of the Site for an Astrophysics Observatory in Brazil* (Rösch, 1969), on which the first studies for this choice were based (Figure 8). This was the report that Muniz Barreto used as the basis for his Preliminary Report I, written in 1966, for use by researchers taking part in the choice of site, but which was published in 1967 under the title, *Notes for the Observations of Choice of Site* (Barreto, 1967). This was followed by a succession of publications by Barreto (1968; 1969a; 1969b; 1969c; 1969d; 1969e; 1973b; 1974; and 1975) that went into the subject from different angles, until the final report (Figure 9) was published in 1982 by Sylvio Ferraz Mello, Barreto's successor in coordinating the choice of site (from 1971 to 1975), with the support of the Institute of Aeronautics and the São Paulo Research Foundation. All of these reports make reference to the initial report by Rösch.

Ferraz Mello (1982) and Germano Quast (pers. comm., 2011), two important figures in the history of Brazilian astrophysics, recognized the positive points in the Rösch Commission report, but suggested that its errors were one of the reasons for the delay in choosing a site. For instance, Pico dos Dias, where the Observatory finally was built, was not even mentioned in the 'Rösch Report' as a possible site.

The other Frenchman on the Rösch Commission, Dr Roger Cayrel, also spent some time in Brazil in 1964 (see Cayrel, 1964) and again in 1967 when he gave an astronomy course (Pacheco, 1994: 23), and both Lício da Silva and José Antônio de Freitas Pacheco worked with him in Paris.

Lício da Silva (b. 1941; Figure 10) earned a degree in physics from the University of São Paulo in 1963, and a Doctorate in astrophysics from the Université de Paris VII – Université Denis Diderot, in 1973. He retired recently from his position as a Professor at the National Observatory, where he also served as Director from 1981 to 1982. He is a member of the Technical and Scientific Center of the National Astrophysics Laboratory and the Brazilian Astronomical Society. His expertise is primarily in stellar astrophysics, and he worked on stellar abundances and stellar atmospheres, and also on the evolution of galaxies.

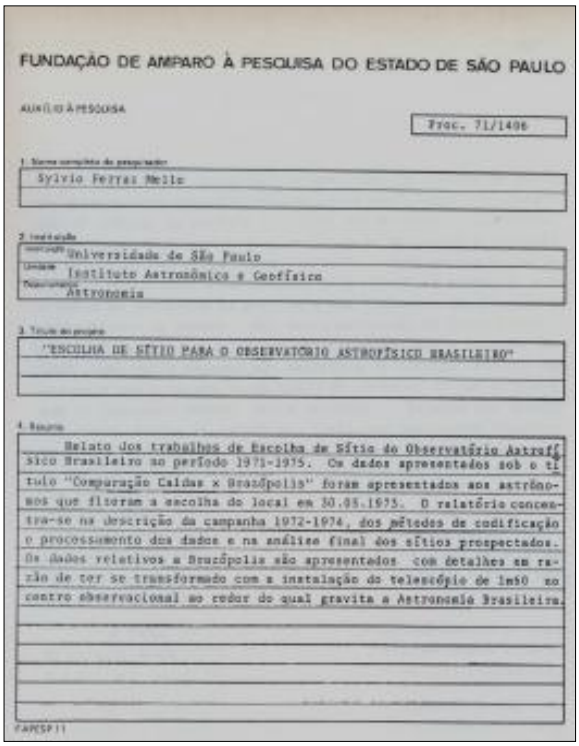

OBSERVATÓRIO NACIONAL
Informação interna nº 15

ETUDE PRELIMINAIRE SUR LE CHOIX DE L'EMPLACEMENT D'UN OBSERVATOIRE ASTROPHYSIQUE AU BRESIL

Jean Rösch
abril de 1969

Figure 8: The Rösch Report (courtesy: MAST archive).

Together with Germano Quast and Carlos Alberto Torres, who will be introduced shortly, Silva is the living memory of the Brazilian Astrophysics Observatory, for he was responsible for establishing it and preparing a three-year plan for 1979 to 1981 (see Silva, 1978). With the administrative changes that took place at the National Observatory in 1979, Silva became coord-


FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO

AUXÍLIO À PESQUISA

Proc. 71/1496

Sylvio Ferraz Mello

Universidade de São Paulo
Instituto Astronômico e Geofísico
Astronomia

"ESCOLHA DE SÍTIO PARA O OBSERVATÓRIO ASTROFÍSICO BRASILEIRO"

Relato dos trabalhos de Escolha de Sítio do Observatório Astrofísico Brasileiro no período 1971-1975. Os dados apresentados sob o título "Comparação Caldas x Brazópolis" foram apresentados aos astrônomos que fizeram a escolha do local em 30.05.1975. O relatório concentra-se na descrição da campanha 1972-1974, dos métodos de codificação e processamento dos dados e na análise final dos sítios prospectados. Os dados relativos a Brazópolis são apresentados com detalhes em razão de ter se transformado com a instalação do telescópio de 1m60 no centro observacional ao redor do qual gravita a Astronomia Brasileira.

FAPESP 11

Figure 9: The final report (after Mello, 1982).

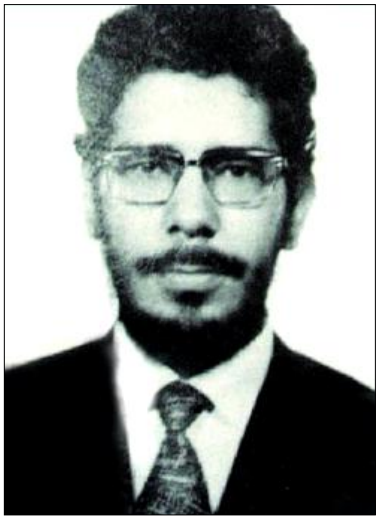


Figure 10: Lício da Silva (courtesy: www.on.br).

inator of the Astrophysics Department. There were also Departments of Astronomy, Radio Astronomy, and Geophysics, headed by Ronaldo Mourão (1935–2014), Jaques Lépine (b. 1946), and Jean-Marie Flexor (b. 1939), respectively. The Director was José Antônio de Freitas Pacheco.

In Silva's three-year plan, we discover that as well as an administrative headquarters in Itajubá and an Observation Center on Pico dos Dias, there would be an Astrophysics Center in Brazópolis (which Silva considered indispensable), and a 1-m telescope would be built. Silva felt that the Astrophysics Center should be near the Observation Center because otherwise productivity would drop by 20%, considerably hampering Brazilian astronomy. In his plan he mentions Itajubá or the neighbouring area, and promises of support from local authorities. As we now know, nothing came of this since the Itajubá premises were only inaugurated in 1992, more than ten years after the installation of the Observatory, but as an administrative headquarters and not as an Astrophysics Center.

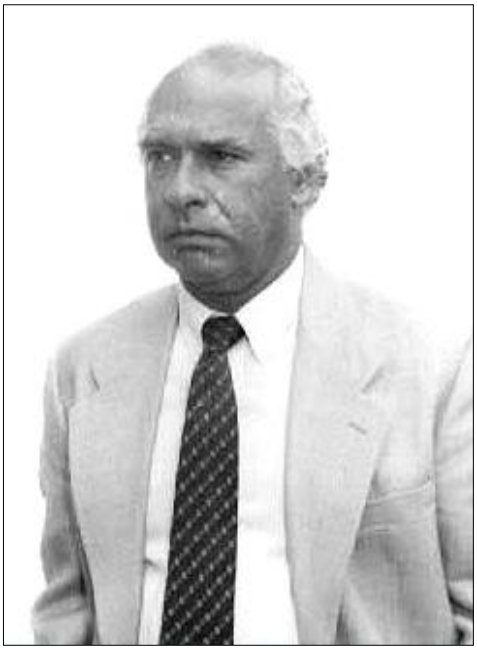


Figure 11: José Antônio de Freitas Pacheco (courtesy: www.on.br).

Before taking on the responsibility of coordinating astrophysics at the National Observatory in the final stages of the implementation of the Brazilian Astrophysics Observatory, Silva was already involved in the choice of instruments, even though he was in France, as we can see from this section of his testimonial about astronomy in Brazil:

> I could give my 'hints' in letters to Muniz, who kindly kept me abreast of the process ... [and] warn of the flaws of the 60" telescope made by Reosc[6] for the ESO, which I knew well because I had used it and because I was a friend of the researcher responsible for its maintenance. (Silva, 1994: 89).

His involvement at this time is also recorded in letters written by Barreto to or about Silva between 1971 and 1973, especially on the subject of instruments, but also about practical matters such as the hiring of Silva and Quast by the National Observatory (e.g. see Barreto, 1971a; 1972a; 1973a).

In March 1982, now as Director of the National Observatory, Silva published an annual report on the institution's activities in *Boletim da SAB*, mentioning the delivery of the Brazilian Astrophysics Observatory to the Brazilian astronomical community the previous year, and how much it represented, given that thenceforth they would have access to "… internationally competitive instruments, which should give their research a new impetus …" (Silva, 1982: 32), which is indeed what happened.

In his paper about astronomy in Brazil titled "The beginning of astrophysics at the National Observatory: a strictly personal testimonial", Silva (1994) reveals a few more of his opinions about the installation of the Observatory, more particularly about the choice of site. He recalls that he was not in Brazil at the time, but he believed that Pico de Caldas would be more advantageous as it was close to a more attractive town (Poços de Caldas), which would help the development of the Observatory and enable the creation of an Astrophysics Center near the telescope (Silva, 1994: 88–89).

Another pioneer of astrophysics in Brazil was José Antônio de Freitas Pacheco (b. 1942; Figure 11). With a degree in physics from the Faculty of Philosophy, Science and Letters of the University of São Paulo in 1965, he was one of the first generation to be captivated by Moraes and Barreto, the mentors of the Brazilian astrophysics project. Appointed a Professor of

Analytical Mechanics at Mackenzie University in 1966, Pacheco was transferred to the Institute of Aeronautics by Moraes in 1967 to teach astronomy and acquire observational experience. It was there that he met, amongst others, Germano Quast, who was concluding his studies, Muniz Barreto, who gave courses in astronomy on weekends, and Sylvio Mello, who was returning from his Doctoral studies in France.

In September 1967, Pacheco went to the Nice Observatory in France, where, in 1971, he defended his Doctoral thesis. Upon his return to Brazil he began lecturing at the Institute of Astronomy and Geophysics at the University of São Paulo, took part in structuring the institution and creating its graduate level courses, and went on to be the first Head of the Department of Astronomy and first coordinator of the Graduate Education Committee. At this same time, the Brazilian astrophysics project was led by Barreto, and a few misunderstandings came to a head. It is worth recalling that the Institute of Astronomy and Geophysics and the National Observatory had already established a clear division of labor, with the former being responsible for training personnel and the latter for choosing the site and instruments. However, the Institute acquired a 60-cm telescope for its graduate students, which, rather than being installed in Brazópolis as Pacheco wished, ended up being installed in Valinhos because of a decision made by the Dean, Miguel Reale. According to Pacheco (1994), Barreto was furious. Today, the telescope is at Pico dos Dias Observatory.[7]

Commenting on the meeting when the site was finally chosen, Pacheco (1994: 27) said that Barreto 'pushed' the decision. However, the fact is that all the institutions involved had made a commitment to choose the site in 1973 because the schedule had to be respected, not least when it came to acquiring equipment, which was already running late.[8] Meanwhile, it was no secret that from 1971 Barreto had complained of a lack of trust demonstrated by some of the people at the Institute of Astronomy and Geophysics (e.g. see Barreto, 1971b).

Pacheco returned to Nice in 1978, but came back to Brazil the following year to take over as Director of the National Observatory (until 1981), where he created the first image and data processing laboratory in the country and reformulated its graduate education area, setting up a course in geophysics and an extensive program designed to increase the number of National Observatory employees with doctorates. It was also at this time that the Brazilian Astrophysics Observatory was created. Pacheco returned to São Paulo in 1985 and took over as Director of the Institute of Astronomy and Geophysics four years later. He then served as Director of the Côte d'Azur Observatory from June 1991 to May 1999. Now retired, he remains active in astronomy in Brazil and in France.

Another representative of the first generation of Brazilian astrophysicists was Sylvio Ferraz Mello (b. 1936; Figure 12), who earned a degree in physics from the University of São Paulo in 1959 and a Doctorate in mathematical sciences from the University of Paris in 1966. He studied the dynamics of the Solar System, especially asteroids, resonance, tides and chaos, plus extra-solar planets, but this was not free of difficulties. On his return to Brazil in 1967 Mello (1994: 33) recalls that

> … the quarrels [with the Institute of Astronomy and Geophysics] continued ... [and] graduate physicists interested in astronomy had to work elsewhere ... I picked ITA [the Technological Institute of Aeronautics] … [where] there was a lot of institutional support.

It was there that he met Germano Quast, Carlos Alberto Torres, Freitas Pacheco, and other young men involved in the Brazilian astrophysics project. Recalling this period, he also highlights the first years when the site was being chosen, the problem of the instruments, and the clearly cooperative nature of the project from the outset (ibid.).

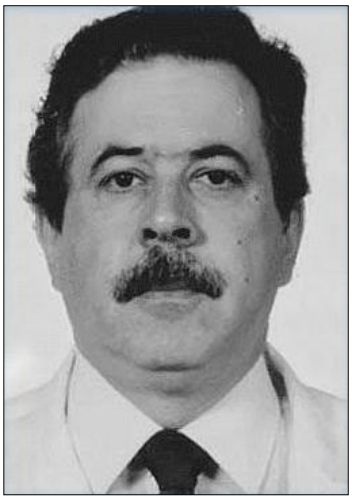


Figure 12: Sylvio Ferraz Mello (courtesy: www.on.br).

Mello took over as coordinator of the studies necessary to choose the site for the Astrophysics Observatory in 1971. He managed to get funding from the São Paulo Research Foundation, and was the author of the final report, written in 1975, which was finally published in *Choice of a Site for the Brazilian Astrophysics Observatory* (Mello, 1982). This book records the period when Mello was responsible for these activities, which were coordinated by the Institute of Aeronautics. As well as the funding from the Institute and the São Paulo Research Foundation, another important source of support was

the 146/CT agreement between the National Observatory and FINEP (the Federal Government's Science and Technology funding agency), signed in 1972, for the construction of a Brazilian astrophysics observatory:

> The acquisition, installation, testing, and entry into operation of the facility, together with the construction of buildings and support facilities, constitute a clear project which, under the responsibility of the National Observatory, has been the subject of an application to FINEP, which resulted in the 146/CT agreement. (Barreto, 1976: 4).

In his book, Mello justifies the choice of Brazópolis and highlights the field work undertaken by this new generation of researchers.

> The group of young researchers that carried it through, doing the field work, deserve every consideration from future generations. And if Brazópolis isn't so wonderful, at least it was the best that could be found within the externally imposed limits of the work. (Mello, 1994: 35).

Several problems ensued because of certain political and scientific forces that were at stake in this project and which had all manner of impacts, especially when it came to institutional interests. The decisions Mello made, whether right or wrong, were largely carried through when it came to the installation of the Brazilian Astrophysics Observatory. He ends his testimonial about this phase of Brazilian astronomy, of which he was not merely a witness but also a key protagonist, by saying:

> … every decision has multiple consequences and deciding involves weighing up opposing elements. What we should never allow is cowardice in the face of a dilemma. The only decision we can be sure is wrong is one that is not taken. (Mello, 1994: 36).

Director of the National Observatory from 1999 to 2001, Mello is now Emeritus Professor at the University of São Paulo and Editor-in-Chief of the journal *Celestial Mechanics and Dynamical Astronomy*. The awards and honorary degrees that he has received include the Great Cross of the National Order of Scientific Merit (Grã-Cruz da Ordem Nacional do Mérito Científico) in 1998 and a Doctor Honoris Causa from the Paris Observatory in 2007. He also had an asteroid named after him (5201 Ferraz Mello, aka 1983 XF) by the International Astronomical Union.

Along with the National Observatory, another institution that played an active role in the Brazilian astrophysics project was the Technological Institute of Aeronautics at the University of São Paulo, which in the mid-1960s set up an Astronomy Department under Ferraz Mello. It was there that Muniz Barreto lectured on weekends, attracting a group of students to the project. Freitas Pacheco also taught there at the same time. Some important meetings were held at the Institute, such as one in 1971, where the São Paulo Research Foundation restricted the choice of sites to Caldas or Brazópolis; one in 1972, when 1973 was set as the deadline for the choosing of a site; and the meeting in 1973, when Brazópolis was finally chosen as the site for the Brazilian Astrophysics Observatory. Let

Figure 13: Germano Quast and Jair Barroso (wearing the cap) on an expedition to choose the site in the 1970s (courtesy: National Astrophysics Laboratory Archive).

us now look a little more closely at three young pioneers of Brazilian astrophysics who studied at the Technological Institute of Aeronautics in São Paulo: Germano Quast, Carlos Alberto Torres and Jair Barroso.

Germano Rodrigo Quast (Figure 13) was born in 1942 in the southern state of Santa Catarina, but he considers himself an honorary citizen of Minas Gerais, since he lived in Itajubá for over 30 years. He has an undergraduate degree in electronic engineering (1966) and a Masters in astronomy (1970) from the Technological Institute of Aeronautics, and a Doctorate in astronomy from the National Observatory (1998). He retired in 2012 as Senior Researcher at the National Astrophysics Laboratory, which he joined in 1989, specializing in young stars and instrument development. Before that he worked at the National Observatory from 1974 to 1989 and at the Techological Institute of Aeronautics from 1967 to 1974. He published extensively, supervised many Masters and Doctoral students, was on many examination panels, and presented his research at many conferences.

Quast's name crops up in all the testimonials and narratives relating to this story, not just concerning the installation of the Brazilian Astrophysics Observatory (the choice of site, training of personnel, and building of instruments), but in all subsequent stages of this story through to the present day, when new strategies are being traced out for the future of Pico dos Dias Observatory (the new name of the observatory), which is still host to the largest telescope in Brazil.[9]

Quast (pers. comm., 2011) has the following to say about the choice of the site:

> I confess that we got into that without much experience, and we did a lot of things wrong, but in the end we made it through … at that time we were trying to take into account only technical criteria. I don't know up to what point that's completely right, but that's the problem, if we started to also take political factors [like the interests of local mayors] into account the whole thing could get tricky.

Quast personally preferred Caldas, but felt that the final choice was technically sound.

Mello (1994: 33) supervised Quast's Masters thesis, and remembers his former student's work at the Institute of Aeronautics, where there was considerable institutional support: "In a short time, thanks to Germano Quast's competence, the first photoelectric photometer worked and the graduate program began." Quast's Masters thesis was the first from the Technological Institute of Aeronautics' graduate astronomy program.

In 1981, when the Brazilian Astrophysics Observatory was inaugurated under the auspices of the National Observatory, Quast was Head of the Astrophysics Department at the National Observatory, a position he held until 1983. In 1989 the National Observatory and the Brazilian Astrophysics Laboratory (the new name for the Observatory) parted ways, and Quast moved to the latter institution, where he was Deputy Director from 1991 to 1994. Shortly before retiring he joined the Program Committee of the Pico dos Dias Observatory and worked in the Scientific Support Department at the office in Itajubá.

Another pioneer of Brazilian astrophysics who came from the Technological Institute of Aeronautics was Carlos Alberto Pinto Coelho de Oliveira Torres (see Figure 14). Born in 1946 to a

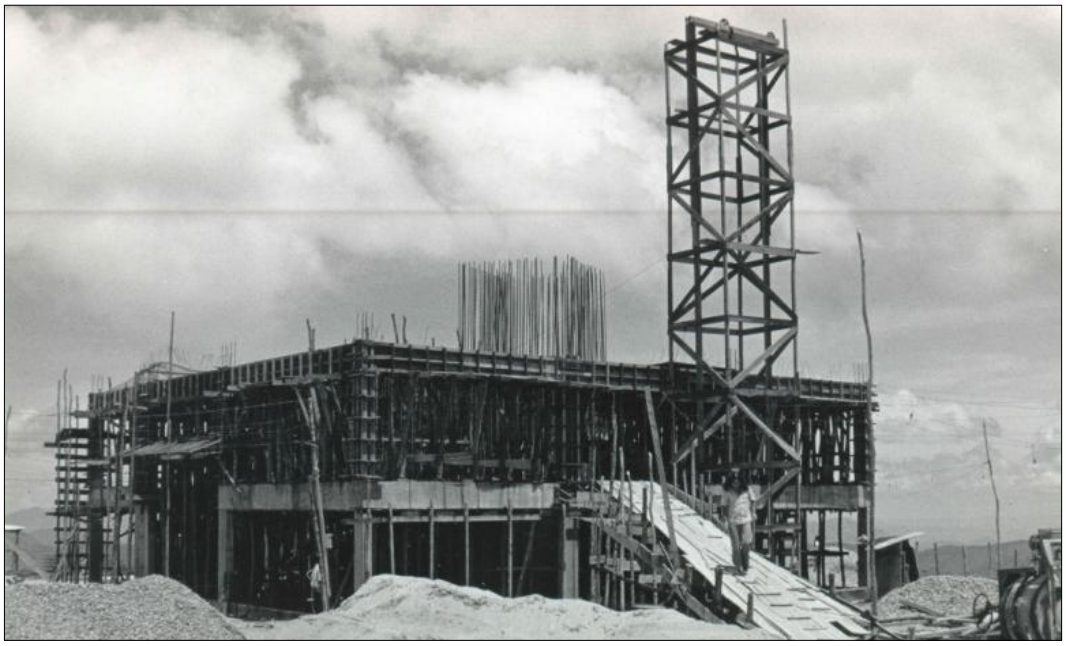


Figure 14: Carlos A. Torres in the ramp of the OAB main building under construction (courtesy: National Astrophysics Laboratory archive).

traditional family in Belo Horizonte, he earned his Bachelors and Masters degrees in physics from the Federal University of Minas Gerais (in 1969 and 1970), a Masters in astronomy from the Technological Institute of Aeronautics (1972) and a Doctorate in astronomy from the National Observatory in 1998. Today, he is Senior Researcher at the National Astrophysics Laboratory, where he has worked since 1989. He also served as the first Director of this institution between 1989 and 1994, shortly after working as Associate Director of the Brazilian Astrophysics Observatory (1986–1989) and head of the same institution (1984–1986), when he was still at the National Observatory, where he was employed from 1973 to 1989. Before he joined the National Observatory, he worked at the Technological Institute of Aeronautics from 1971 to 1973 and at the Federal University of Minas Gerais from 1966 to 1971. His long scientific career includes numerous publications (with >1,000 citations), supervision of graduate students, participation in examination panels, and the presentation of many research papers at conferences and seminars.

Torres is another protagonist of this story because he was actively involved in the installation of the mountain observatory, and he pursued part of his career at this observatory, in much the same way as Quast did. While he was not involved in the selection of the site or the instruments for the Brazilian Astrophysics Observatory, he was one of the pioneers of Brazilian astrophysics and, together with others of his generation, came of age at this time with his sights set on taking full advantage of this observatory.

Mello (1994) supervised Torres' Masters thesis, *Luminosity Variations in Red Dwarfs*, and he has much praise for Torres and his peers from Minas Gerais. Torres conducted research in stellar astrophysics, and especially in pre-main-sequence stars, young stars, young associations, and infrared and X-ray sources, as can be seen from his doctoral thesis, *Pico dos Dias Survey of Young Stars*, which drew on research carried out at the new observatory. Silva (1994), who supervised Torres' Doctoral work, speaks of Torres in his testimonial about Brazilian astronomy, and also reveals the precarious state of Brazilian astrophysics at that time.

In 1981, when the Brazilian Astrophysics Observatory was inaugurated while still under the National Observatory, Torres was an Assistant Researcher there, a position he held until 1983. He was appointed Associate Researcher in 1986 and full Professor in 1988. In 1989, when the National Observatory and the Brazilian Astrophysics Laboratory parted company, Torres moved to the latter, where—as we have already seen—he served as its first Director, from 1989 to 1994. He is currently interim Coordinator of Scientific Support at its headquarters in Itajubá. All this experience was recorded in a recent chapter of a book on astronomy in Brazil (see Torres and Barboza, 2014).

Another pioneer of astrophysics who studied at the Technological Institute of Aeronautics was Jair Barroso Jr. (b. 1937), who in 1959 earned his Bachelors degree and teaching certificate in physics from the State University of Guanabara (now the State University of Rio de Janeiro), and a Masters in astronomy from the Technological Institute of Aeronautics (1971), where he studied with Quast and Torres and was supervised by Mello. Even before he graduated he worked as an Assistant Astronomer at the National Observatory (in 1956). He retired in 1993 from this institution, which since 1976 was linked to the National Council of Scientific and Technological Development. Barroso devoted much of his life's work to astronomical instrumentation and observation. His main areas of interest were astronomical timekeeping using meridian observations; the installation and modification of telescopes; the choice and testing of astronomical sites; photoelectric photometry; light curve analysis; mutual phenomena of Jupiter's satellites; occultation of stars by the Moon and other Solar System objects; and the teaching and communication of astronomy.

Just like Quast, Barroso took part in all the three action lines in Moraes and Barreto's astrophysics project: the training of personnel, choice of site and instrumentation. Barroso's Master's thesis was titled *Analysis of Light Curves of Eclipsing Binaries. Applications to the Star BV590*, and Barreto (1972b) said that this broke new ground in astrophysics. From the early 1970s Barroso was actively involved in the selection of a site for the Brazilian Astrophysics Observatory, and he even had some special responsibilities, as can be seen from several personal and official letters, telegrams, and directives issued by the National Observatory.[10]

Other young astronomers and meteorologists also took part in this project to develop Brazilian astronomy, especially after the multi-institutional assault on the total solar eclipse of 1966. As Videira and Vieira (1997: 22) explain:

> The opportunity to bring together researchers and institutions around the construction of a modern observatory emerged with the solar eclipse of Bagé (Rio Grande do Sul) in 1966. The integration of the scientific community proved fundamental for overcoming financial, political, and scientific hurdles. The realization of the longstanding ideal came 15 years later when, in 1981, the Brazilian Astrophysics Observatory, now the National Astrophysics Laboratory, was inaugurated in Brasópolis ...

According to one of the participants at this event, Oscar Toshiaki Matsuura (2014), the activity around the eclipse forged bonds and marked the beginning of the need for more frequent meetings of the Brazilian astronomical community. Another participant, Paulo Marques dos Santos (pers. comm., 1999), noted that there also were observing teams from Italy, the Netherlands and the USA) at the event, which was a milestone for Brazilian astronomy. Quast (pers. comm., 2011) also confirmed the important contacts that were made on this occasion, especially, in his own case, with Moraes and Barreto.

Paulo Marques dos Santos (b. 1927) has a degree and teaching certificate in physics, but before he earned his degree he already worked in meteorology at the Institute of Astronomy and Geophysics at the University of São Paulo, where he later lectured and earned his Masters and Doctoral degrees. Splitting his time between astronomy and meteorology, his story is very much the story of this Institute, where he continues to work every day, even though he retired in 1997.

As for his involvement in our story, it is important to note that between 1962 and 1973 Santos, along with fellow-Brazilians Moraes and Barreto, was a member of the Rösch Commission, which laid the groundwork for the installation and operation of the future Brazilian Astrophysics Observatory. Indeed, in a report on Brazilian astronomy Santos (1994) clearly links Brazil's re-admission to the International Astronomical Union to the creation of the Rösch Commission and this initial stage of the Brazilian astrophysics project.

In an interview with Videira and Matsuura, Santos (pers. comm., 1999) informally recounts his version of the choice of site for the mountain observatory, or the 'large-scale observatory' as it used to be called, and supplies some new details. Having attended the Rösche Commission's meteorology meeting, he recalls some of the criteria for the choice:

- as far south as possible,
- altitude
- not too far from a city
- isolation
- glare
- cloud cover
- temperature
- winds
- precipitation
- humidity

These should be chosen to enable the highest possible number of nights of observation and the best quality images (with specific instruments). About Brazópolis, Santos was categorical: it was too cloudy, and everyone knew there were better peaks in the region (like Maria da Fé), and it was too humid (it was full of banana trees). The US Air Force map shown in Figure 15 was used during the search for a suitable observatory site.

But this was the site that finally was chosen in 1973, after extensive studies by and discussions within the burgeoning Brazilian astronomical community. Then, seven years later, a 1.60-m Perkin-Elmer telescope was installed on the top of the mountain (see Figure 16).

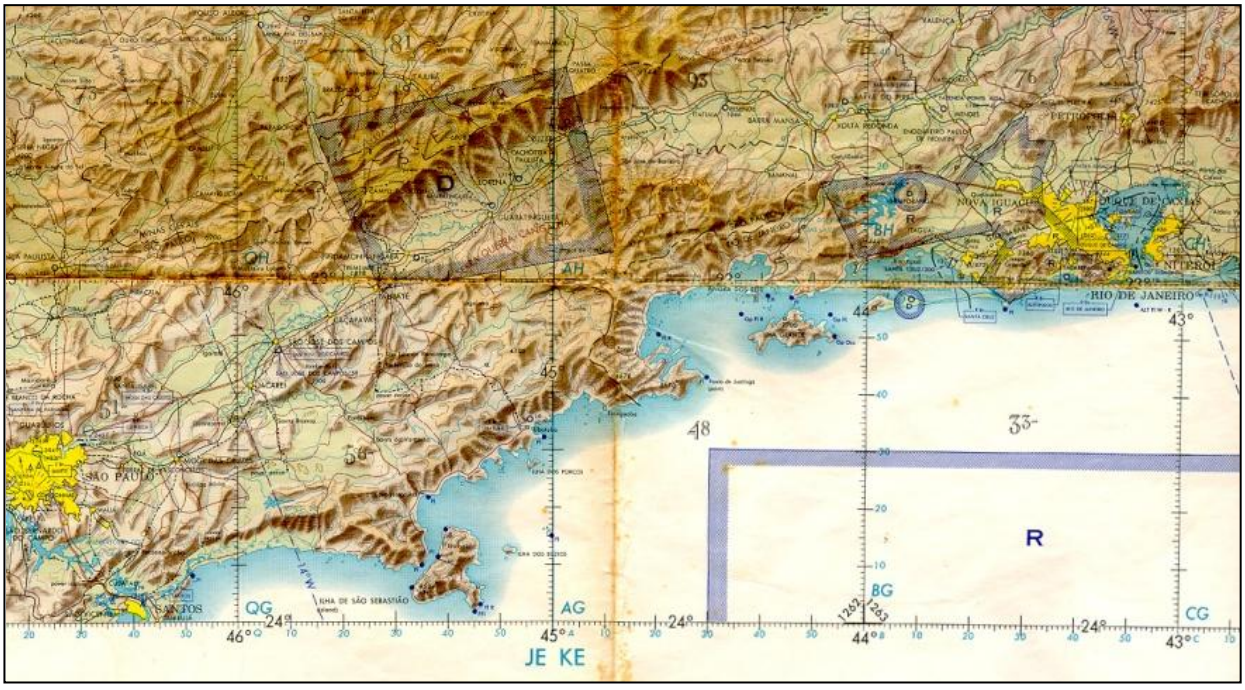


Figure 15: The US Air Force Operational Navigational Chart used during the search for a suitable observatory site (courtesy: National Astrophysics Laboratory).

Figure 16: Installation of the Perkin-Elmer telescope in 1980 (courtesy: National Astrophysics Laboratory archive).

4 A NEWBORN OBSERVATORY

Despite all the difficulties, the long dreamt-of 'mountain observatory' finally became a reality, and first light was obtained on 22 April 1980 (before the official inauguration in 1981) by Ivo Busko and Francisco Jablonski according to Quast and Torres (pers. comm., 2011) when they observed a dMe flare star (see Busko et al., 1980). In the second paragraph of this paper they describe this historic moment:

> In 4 nights between April and June 1980, the star was monitored photoelectrically in the U band with the 1.6m telescope of Brazilian Astrophysical [*sic*] Observatory. (Busko et al., 1980: 1).

The effective inauguration of the Brazilian Astrophysics Observatory took place on 19 February 1981. Two months later, according to Pacheco (1981: 7), who was then Director of the National Observatory, Brazilian astronomers could already submit proposals to the Program Committee and use the Observatory's Perkin-Elmer telescope, which was supplied with coudé and Cassegrain spectrographs, a camera for direct photography, a photopolarimeter and a photometer. In 1982, a 60-cm Zeiss telescope also was installed at the Observatory. This instrument had been donated to the Federal University of Rio de Janeiro as the result of negotiations between Brazil and the German Democratic Republic in the early 1970s.

The first Program Committee responsible for allocating observing time on the telescope was chaired by Lício da Silva from the National Observatory, and other members of the Committee were Germano Quast and Jorge Ramiro de La Reza (also from the National Observatory), Miriani Pastoriza (b. 1952) from the Physics Institute at the Federal University of Rio Grande do Sul, and Eduardo Janot Pacheco (b. 1945) from the Institute of Astronomy and Geophysics at the University of São Paulo. The idea was that this committee should be representative of the community of users and that it should take into account the scientific merit of the researchers' track records and planned studies, using a system of arbitration (Director of SAB, 1982). In 1982, the Program Committee gained a new community member, and in 1984 a report was published on the use of the Perkin-Elmer telescope from 1981 to 1984. This provided some background information about the Committee, and explained its selection criteria, the frequency of its meetings and the time taken for it to decide on applications. It also included statistics on the use of the telescope and its efficiency, and listed publications that used data derived from the Observatory (Program Committee …, 1984).

The most notable projects from these early days included: photometric observations of cataclysmic variables, mainly by Busko and Jablonski; the development of a Reticon detector in collaboration with the Harvard Center for Astrophys-

Figure 17: A view of the Brazilian Astrophysics Observartory (now the Brazilian Astrophysics Laboratory; courtesy: Dronestagr.am).

ics; the first version of the rapid photometer for the Brazilian Astrophysics Observatory by Jair Barroso; and the study and calculations for prime focus correctors for the Brazópolis telescope.

In terms of infrastructure, there was already a mechanics workshop with small machines, an optics laboratory, and an electrical/electronics laboratory, all three under the Engineering Department, which was headed by Clemens Darvin Gneiding. Three other departments made up what was known as the Brazilian Astrophysics Observatory Division of the Department of Astronomy, which was under the National Council of Scientific and Technological Development and the National Observatory: the Data Acquisition and Processing Department, the Administrative Support Department and the Operations Center (with instruments and a photographic laboratory). The Head of the Operations Center was Rodrigo Prates Campos, the only professional photographer in Brazil who specialized in astronomy. There also was a library managed by Carlos Alberto Torres. Observing time was divided between astronomers from the National Observatory and elsewhere in the country, as the Brazilian Astrophysics Observatory was deemed to be a 'national laboratory' along with other facilities under the National Council of Scientific and Technological Development. As a result, soon astronomical research papers were being produced as Brazilian astronomy entered a new era.

5 CONCLUDING REMARKS

Muniz Barreto's efforts to make the dream of his mentor, Domingos da Costa, come true; the return to Brazil of young doctoral graduates like Ferraz Mello, Freitas Pacheco and Lício da Silva, who were encouraged to study abroad by Abrahão de Moraes; the attraction of these returning astronomers and local graduate students like Germano Quast and Carlos Alberto Torres to the Brazilian astrophysics project: these were just a few of the factors that combined in the second half of the 1960s to make the first steps for the creation of the Brazilian Astrophysics Observatory possible (Figure 17). During this period, these astronomers and others prepared and executed a program to choose a site, acquire and install a large telescope and train personnel for this Observatory. This was all uncharted territory and certainly involved much trial and error, but it also represented a great new impetus for astronomical research in Brazil.

Previously, astronomical research had tended to be theoretically-oriented, but with the founding of the new observatory observational astronomy quickly became the norm. Brazilian researchers could now gather data in Brazil. At the same time, graduate programs in astronomy were introduced at Brazilian universities, and astronomy was institutionalized throughout the country, especially through the annual meetings of the Brazilian Astronomical Society, and other events. All of these developments were interlinked. The Brazilian Astrophysics Observatory was actively involved not only in the institutionalization of the field, but also in training astrophysicists in instrumental and observational skills.

Throughout this period, national and international cooperation formed the backbone of the scientific and technological interchanges neces-

sary to develop astronomy. The Brazilian Astrophysics Observatory was intimately linked with this sustained drive to develop Brazilian science and science policies. The new Observatory, previously under the National Council of Scientífic and Technological Development and the National Observatory, gained autonomy in the late 1980s and changed its name to the National Astrophysics Laboratory. It became the first national laboratory in the country, and was incorporated into the institutional structure of the National Council of Scientífic and Technological Development as a research unit.

We might wonder about the political circumstances in Brazil throughout this period. Something that immediately stands out is that the project was conceived during a dictatorship—indeed, two dictatorships (Vargas and the military regime)—which certainly helped, since the regime facilitated decisions taken by small groups of people. But the Brazilian Astrophysics Observatory broke away from the National Observatory and was renamed after the return to democracy. At the turn of the century, under new political circumstances, it was reclassified as a research unit under the Ministry of Science and Technology (now the Ministry of Science, Technology, and Innovation). At the same time as it witnessed great national transformation, the Brazilian scientific community built this and other institutions, learnt how to manage them, developed astrophysics and carved out a place for Brazil in the international field of technology. In the midst of all this, the National Astrophysics Laboratory is reaching its prime, and is now also reaching out to the public to pay back the investment made over the years through a host of educational and science communication initiatives, such as open days at the Observatory, an on-line journal called *LNA em Dia*, and the 'Observatory on the Rooftop' program.

6 NOTES

1. A final introductory remark must be made. The revitalization of Brazilian astrophysics cannot be fully understood solely through the development of the Brazilian Astrophysics Observatory. At the same time that its construction was being debated, a small group of astronomers in the state of São Paulo built and put into operation some small radio telescopes, which were used mainly for research on radio emission from solar flares. For further information about the development of Brazilian radio astronomy see Barbuy et al. (1994) and Matsuura (2014).
2. In some references his name appears without the 'da'. We have adopted the name as it appears in the National Observatory documents, and throughout this paper we use the same criterion for other proper names, both Brazilian and foreign.
3. Throughout this research paper, the authors have translated the titles of books, theses, research papers and archival records, and quotations from these and other sources, into English.
4. For budget details see Moraes (1961b).
5. This collaboration between Brazil and France continued an astronomy partnership between these two countries that had existed during the late nineteenth and early twentieth centuries.
6. REOSC, a French optical company founded in 1937, was one of the three possible manufacturers being evaluated. The others were Carl Zeiss and Perkin-Elmer (Boller & Chivens Division), and it was the last of these which ended up being chosen.
7. It was installed in 1992.
8. See the papers about the National Observatory in the archives of the Museum of Astronomy and Related Sciences (Box 45, Folder about OAB).
9. For example, see the 69-page docuument titled "Preparation of Strategies ...", 2011).
10. See papers about the National Observatory in the archives of the Museum of Astronomy and Related Sciences (Box 51, Letters and Cables of 1972).

7 ACKNOWLEDGEMENTS

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MAST = Archive of the Museum of Astronomy and Related Sciences
ON = National Observatory

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