

WHERE EXACTLY DID A.S. EDDINGTON OBSERVE THE TOTAL SOLAR ECLIPSE OF 29 MAY 1919?

ONDE, EXACTAMENTE, A.S. EDDINGTON OBSERVOU O ECLIPSE SOLAR DE 29 DE MAIO DE 1919?

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Abstract: The team led by astronomer A.S. Eddington observed the total solar eclipse of 29 May 1919 from Sundry Plantation situated on the African island of Príncipe. Together with observations made in Brazil by the other British team, these results proved the light-bending prediction put forward by Albert Einstein.

Over the past 100 years, during a long period of inattention, plaques were erected at Sundry Plantation at different times and at various locations to commemorate this important scientific event. With one exception, the locations of these plaques varied, mainly as a result of logistical constraints, rather than historical research. At the centenary celebrations of the 1919 eclipse organized by *Eddington at Sundry: 100 Years Later*, the exact site where the observations took place was identified. As a result of interdisciplinary teamwork involving experts in history of science, mathematics, architecture and anthropology, members of the local community and a Santomean artist, the exact location of the observations has now been artistically sign-posted.

This research paper discusses the convoluted process that led to this identification. Furthermore, it argues that besides the intrinsic value of interdisciplinary research, this identification empowered local communities by enhancing their collective memory of a ground-breaking scientific event that is indelibly tied to their past, while boosting their development through scientific education and communication.

Keywords: 1919 total solar eclipse, British expeditions, Eddington, Príncipe

Resumo: A equipa liderada por A.S. Eddington observou o eclipse solar total de 29 de Maio de 1919 na Roça Sundry, na africana ilha do Príncipe. Juntamente com as observações feitas no Brasil, por outra equipa britânica, estes resultados confirmaram a deflexão da luz de acordo com a previsão de Albert Einstein.

Ao longo destes 100 anos, durante um longo período de esquecimento, foram erguidas placas na Roça Sundry, em momentos e localizações distintas, para sinalizar esse importante evento científico. A exceção de uma situação, os locais dessas placas foram escolhidos sobretudo devido a restrições logísticas, e não apoiados por investigação histórica. Nas celebrações do centenário do eclipse de 1919 organizadas no âmbito de *Eddington na Sundry: 100 Anos Depois*, foi identificado o local exacto onde as observações astronómicas decorreram. O resultado de um trabalho de equipa interdisciplinar envolvendo especialistas de história das ciências, matemática, arquitectura, antropologia, membros da comunidade local e um artista santomense, permitiu identificar a localização exacta das observações que foi agora artisticamente sinalizada.

Neste artigo discute-se o processo que conduziu a essa identificação. Argumenta-se que, para além do valor acrescido de uma investigação interdisciplinar, esta identificação empoderou as comunidades locais ao devolver-lhes uma parte integrante da sua memória colectiva de um evento científico inovador, o qual está indelevelmente associado ao seu passado, ao mesmo tempo que promoveu o seu desenvolvimento através da educação e comunicação científicas.

Palavras-chave: Eclipse solar total de 1919, Expedições britânicas, Eddington, Ilha do Príncipe

1 WHEN HISTORY OF SCIENCE MEETS THE HISTORY OF PRÍNCIPE

Unquestionably the most important event in which history of science met the history of the small African island of Príncipe is associated with the total solar eclipse of 29 May 1919, which was observed by a British team of astronomers. Together with the observations of the sister expedition which observed from Sobral in Brazil (see Figure 1), they contributed to the validation of the then recent Theory of General Relativity put forward by Albert Einstein (1879–1955). Published in 1915, among its three astronomical predictions was the deflection of light when passing close to a large gravitational mass, such as the Sun. The value predicted by Einstein was $1.75''$, twice that predicted by the Newtonian theory of gravitation ($0.87''$), if one accepted the corpuscular nature for light (Dyson et al., 1920; Mota et al., 2008).

Organized by the Joint Permanent Eclipse Committee, which brought together members of the Royal Astronomical Society and of the Royal Society of London, in order to promote expeditions to observe solar eclipses, the expedition that headed for Príncipe included the astrophysicist Arthur Stanley Eddington (1882–1944) and clock expert Edwin Cottingham (1869–1940), while the expedition that headed for Sobral included the Greenwich astronomers Andrew Claude de la Cherois Crommelin (1865–1939) and Charles Rundle Davidson (1875–1970). These astronomical expeditions, as well as others organized since the mid-nineteenth century, reflected the spirit of British imperialism, which used science and technology as weapons to affirm power in the service of the Empire (see Pang, 1993; 2002).

Following usual practice, contacts were established between British institutions and institutions in the host countries where the observations were going to take place. As such Brazilian and Portuguese institutions—São Tomé e Príncipe was then a Portuguese African colony—were contacted to obtain geographical and meteorological information essential for the choice of observing sites as well as to get logistical help, including transportation and accommodation for teams in Sobral and on Príncipe. The Director of the National Observatory of Rio de Janeiro, Henrique Morize (1860–1930), and the Deputy-Director of the Lisbon Astronomical Observatory, Frederico Tomás Oom (1864–1930), played key roles as intermediaries between the expeditions, local institutions and agents. For example, see Videira (2020) for an account of Morize's role and his attempt to observe the eclipse.

Observational conditions were very different, both geopolitically and meteorologically. On the one hand, Sobral was the second largest city in the north-eastern Brazilian State of Ceará, while Príncipe was at the periphery of the extensive Portuguese colonial empire, that just over a decade earlier had been involved in a conflict with British authorities over working conditions in the cocoa plantations, which were considered by some to effectively constitute slavery. On the other hand, the extreme drought that was ravaging Sobral had devastating consequences for the local population but it did not jeopardise the eclipse observations, while the end of the rainy season in Príncipe was not particularly favourable for the astronomers. In addition, in Sobral English travellers were accompanied by two other teams of expeditioners, a Brazilian and an American, and counted on the support of an interpreter and assistant, while in Príncipe the British team was unaccompanied, although local support was enthusiastically offered (Moreira and Videira, 1995; Rodrigues, 2012; Simões and Sousa, 2019).



Figure 1: A map showing the path of totality of the 29 May 1919 total solar eclipse, with the positions of Sobral and Príncipe marked in blue (Google Earth; map modification: Joana Latas).

The very different situations at the two locations also were reflected in very different local public registers: profuse in the case of Sobral and non-existent, as far as we know, in the case of Príncipe. Indeed, in Sobral, the local, state, regional and national press extensively covered the event, including interviews with the astronomers. Together they convey their impressions of the local context, but also they enable us to learn about how the local participants perceived the expedition members and their objectives (Rodrigues, 2012). In the case of Príncipe, no accounts in the colonial press have thus far been found, while in the metropolis they are very sparse. Therefore, as yet, no information about the

reactions of local communities has been discovered. The same distinction occurs with regard to the pictorial record, with many photographs of the expedition in Sobral but none in Príncipe.

The 1920 joint research paper authored by the Astronomer Royal Sir Frank Dyson (1868–1939) and the two astronomers Eddington and Davidson, titled “A determination of the deflection of light by the Sun’s gravitational field, from observations made at the total eclipse of May 29, 1919” (Dyson et al., 1920) offers a detailed record and analysis of the scientific results of the expeditions, following their announcement at the joint meeting of the Royal Astronomical Society and the Royal Society of London, on 6 November 1919 (Joint eclipse meeting ..., 1919). However, the correspondence Eddington sent to his family (mother and sister), held at the Trinity College Archives, of which there is no parallel for Sobral, not only conveys travellers’ impressions on their natural, social, and cultural context but also provides detailed scientific information, at times complementing or even surpassing those in the public sources. To give a few examples: in the letter of 21 June–2 July 1919 Eddington lists by name and/or profession those members of the local elite who observed the eclipse, and probably helped with the observations; in another dated 29 April–2 May 1919, as well as in the 1920 joint paper, he refers to local, anonymous workers who helped transport the travellers’ luggage from the city of Santo António to Sundy Plantation,¹ and subsequently helped in the construction of the pier for the *cœlost*at, and in the equipment’s installation (Simões, 2019; Simões and Sousa, 2019). This additional information is a first step towards counteracting the perverse historical effect dubbed suggestively as “... the ‘eclipse’ of Príncipe.” (Weszkalns, 2009).

Despite a wealth of history of science publications involving the British expeditions to Sobral and Príncipe, mostly discussed separately, and the analysis of their impact on national scientific communities in Brazil and Portugal (recent ones include Bozi and Pessoa, 2019; Crispino and Lima, 2016; Tolmasquim and Moreira, 2019), the echoes of the 1919 total solar eclipse have gone largely unnoticed for local (and at times even national) populations both in Sobral and on Príncipe. Taking this omission seriously, the centenary celebrations provided a privileged occasion to bring local populations in contact with their forgotten scientific past, offering various ways for its local celebration.

Inspired by public and private, national and international actions, including the substantial intervention of the Regional Government of Príncipe (RGP), this paper discusses the convoluted process that led to the identification of the exact location of the telescope used by Eddington and Cottingham. As a result of interdisciplinary team-work involving experts in history of science, mathematics, architecture and anthropology, members of the Sundy local community and a Santomean artist, the exact location of the observations is now artistically sign-posted. Furthermore, this paper argues that this identification empowers local communities by enhancing their collective memory of a ground-breaking scientific event that is indelibly tied to their own past, whilst boosting their development through scientific education and communication.

2 SIGNALING A FORGOTTEN SCIENTIFIC EVENT

Members of the British expedition arrived in Príncipe on 23 April 1919. They stayed on the equatorial island for approximately seven weeks, returning to the port of Liverpool on 12 June. The tiny island of Príncipe is the smallest island in the São Tomé e Príncipe archipelago located in the Gulf of Guinea on the West coast of Africa (see Figure 2) and it occupies an area of around 140 square kilometres. In 1919, when visited by the British team its population was nearly 6000 inhabitants; one century later its population had increased by about 50% (Agência Geral das Colónias, 1929; Instituto Nacional de Estatística, 2015).² After a short stay at the city of Santo António, they settled in at the Sundy Plantation, on the north-western part of the island at an altitude of 500 feet (Figure 3). Sundy was one of the island’s largest agricultural facilities and cocoa plantations. Jerónimo José Carneiro, Sundy’s owner and President of the Association of Planters (Associação de Plantadores), welcomed them and provided all possible comfort and amenities. Preparatory work began with the choice of the best possible location for the observations, luggage transportation from Santo António to Sundy, and installation and testing of the equipment. Some anxiety built concerning the probable meteorological conditions during the 302 seconds of totality, but social events, including picnics, tennis games and soirées spent with the island’s elite, distracted travellers from their scientific worries (Simões and Sousa, 2019).

On 29 May, the vital day, it rained heavily before the beginning of the eclipse and the sky was cloudy during the eclipse. Nine people—

Jerónimo José Carneiro, the 'curador' (the man in charge of imported labour), the judge, Wright (one of the two cable station specialists) and three doctors—came over to support the observations, eventually helping Eddington and Cottingham by giving the fundamental indications for the plate changes at appropriate times. Despite the unfortunate conditions, Eddington's optimism was expressed in the telegram sent to Dyson, which simply stated: "Through cloud, hopeful" (*The Observatory*, 1919). Of the sixteen plates taken, just twelve could be developed on site, with the help of ice, which ensured adequate water temperatures and was provided by a local resident. Only two of the sixteen plates registered five stars (Davidson, 1922; Dyson et al., 1920; Hinks, 1917; Mota et al., 2008).

If an attentive reading of Eddington's correspondence reveals the participation of the elite and local workers, so far there has been no way to picture exactly if and how the memories of this event survived among inhabitants of Príncipe: the colonial press did not seem to exist during this period, no documents have been retrieved so far in the local archives or in the archives of the family of Jerónimo José Carneiro, and scant and blurry oral memories have passed from generation to generation among descendants of Sundry workers.



Figure 2: Geographic location of the São Tomé e Príncipe archipelago in Gulf of Guinea on the West coast of Africa. Príncipe is the more northerly of the two circled islands (Wikimedia Commons).

The same happened among Portuguese authorities for a long time. In 1967, around fifty years ago, and almost five decades after the eclipse, José de Azevedo e Silva seems to have been the first to recall the importance of this epoch-making scientific event for the history of São Tomé e Príncipe. In a journal's issue commemorating the discovery of the island of São Tomé, he stated:

In the same way that a plaque signals the Equator's position in the islet of Rolas as determined exactly by Admiral Gago Coutinho,³ in Príncipe, where the plates of the solar eclipse were taken, a stone and ce-

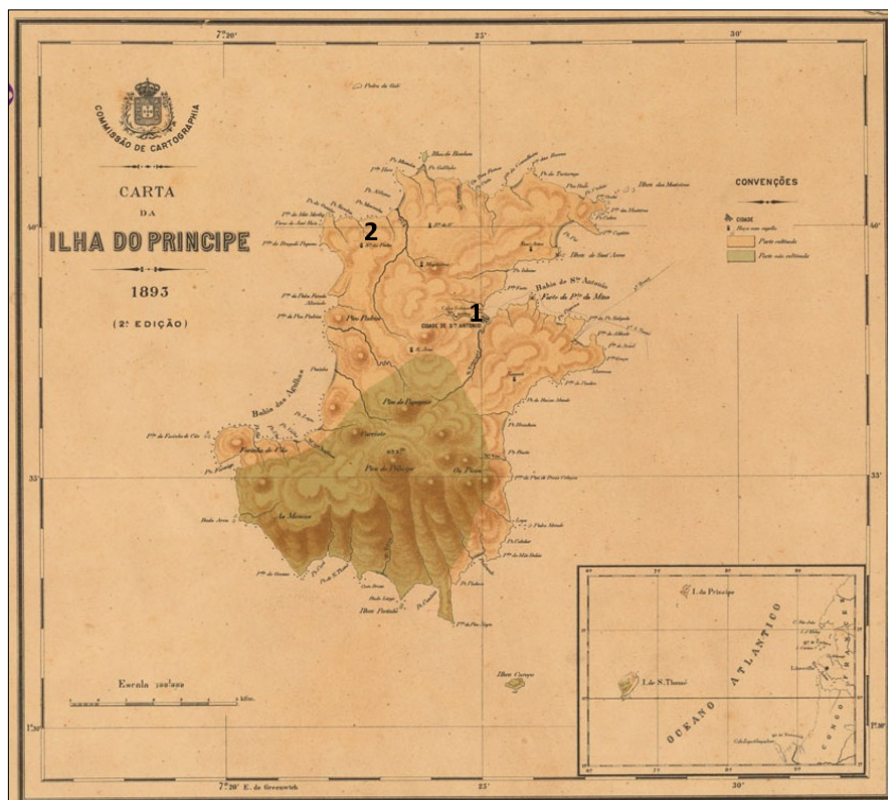


Figure 3: The cartographic map of the island of Príncipe sent to Arthur Hinks in London, by the Secretary of the Sociedade de Geografia de Lisboa, Ernesto Vasconcelos, on March 1917, during preparations for the 1919 expedition. Key: 1: Santo António city; 2: Sundy Plantation (Associação Caué, 2010; map modification: Joana Latas).



Figure 4: The commemorative plaque signalling the seventieth anniversary of the 1919 total solar eclipse. Initially placed in front of the Administration House, presently this plaque is located on the western façade of the house (Courtesy: HBD PRÍNCIPE).

ment plaque should at least signal this historical date for science, if it does not do so yet (Silva, 1967: 249).

Silva's challenge went unanswered until 1989, on the occasion of the seventieth anniversary of the observations by Eddington and Cottingham. In 1970, Eugénio Anacoreta Correia, then a Professor at the University of Luanda, found this text while preparing a study trip to São Tomé e Príncipe. Years later, when he returned to the archipelago as Ambassador of Portugal (1988–1993), he decided to take the matter into his own hands. Together with Manuel Pinto da Costa, then President of the Democratic Republic of São Tomé e Príncipe, Celestino Costa, Prime Minister, and Carlos Ferreira, Minister of Social Equipment and Environment, it was decided to mark the seventieth anniversary of the observations of the 1919 total solar eclipse at Príncipe with an appropriate plaque. The initiative was financially and logistically supported by Portuguese institutions, and counted on the scientific ad-



Figure 5: The plaque provided by RAS to mark the celebrations of the ninetieth anniversary of the 1919 eclipse. The plaque was placed on the terrace next to the marble plaque (after Massey, 2009).

vice of the mathematician David Lopes Gagean and the philosopher of science Manuel Costa Leite. In the previous year, they co-authored the article “The deflection of light rays in a gravitational field”, in which Eddington's expedition to Príncipe is cursorily discussed, together with a reference to the role of Portugal and the criticism concerning the absence of any Portuguese astronomer (Gagean and Leite, 1987), which has since been subsequently clarified (Mota et al., 2008). On 29 May 1989, in the yard at Sundry, in front of the main building (named the Administration House, or Casa da Administração),⁴ a marble plaque was unveiled by Ambassador Anacoreta Correia, at a ceremony that included Minister Carlos Ferreira (Figure 4).

In 2009, on the occasion of the ninetieth anniversary of the expedition, the Geographical Society of Lisbon (Sociedade de Geografia de Lisboa), with the collaboration of the RGP and the Royal Astronomical Society (RAS), among others, signalled the occasion with an international meeting and scientists from the United Kingdom, Portugal and Brazil gathered on Príncipe (Barros, 2010). The anniversary was also marked with a new plaque offered by the RAS, which was placed next to the existing one, and was unveiled by José Cardoso Casandra, President of the Regional Government of Príncipe, and by Nestor Umbelina, the Secretary for the Environment, Natural Resources, Infrastructure and Territorial Planning (Ellis et al., 2009) (Figure 5).

Two years later, in 2011, following the work of the Spanish artist Paloma Polo, carried out with the support of the RGP, the marble plaque was moved by members of the Plantation community, who were the descendants of the last generation of forced labourers, to the rear of the Administration House, to a spot identified by Polo as the location of Eddington's astronomical set up. Polo's educated guess was the result of cross-checking information from the coordinates of the installation identified in the 1920 report published by Dyson, Eddington and Davidson (Dyson et al., 1920), with information taken from the letter Eddington wrote to his mother, dated 29 April–2 May 1919, information from family members of Jerónimo José Carneiro, and from guessing the probable existence of guest-rooms that had views to the rear of the Administration House. In a 16-mm film called *Action at a Distance*, Polo depicted the change of the plaque's location, at the same time filming the local audience that witnessed the transfer, thereby suggesting new perspectives on the appropriation of time and space by the local community. Her

work led to the exhibition called *Apparent Position*, which took place at the Museo Nacional Centro de Arte Reina Sofía in Madrid, from 25 January to 23 April 2012, and can be analysed in the associated catalogue (Polo, 2012).

In 2013, a partial solar eclipse, visible on the island of Príncipe, provided another pretext for recalling the 1919 eclipse. Integrated in the International Year of Mathematics of Planet Earth, an event called *Eclipse 2013: History and Science* was organized in Príncipe by the RGP, in collaboration with the private company HBD⁵ (renamed presently as HBD PRINCIPE), a private hybrid corporation (with profit and non-profit goals) that invests in the development of sustainable and responsible tourism in Príncipe. Apart from attracting the national and international scientific community, this event addressed society at large, and especially local teachers and students, and aimed at the promotion and dissemination of science, while at the same time reaffirming the scientific legacy of Príncipe (Latas and Cardoso, 2014).

Since then, every year on 29 May, initiatives from the secondary school system of Príncipe, supported by the RGP, have taken place. Building on the recognition by UNESCO of Príncipe as a World Biosphere Reserve, we highlight the creation of a 3-km educational Science Trail (Trilho da Ciência), connecting science, history and local culture in order to

demystify, and understand various scientific topics (Latas and Rodrigues, 2015). Stops offer diverse scientific activities, ranging from biology, geology, physics and history, all directly related to Príncipe, based on the integration of hands-on (involvement of the 5 senses – doing), minds-on (cognitive involvement – thinking), and hearts-on (emotional involvement – feeling) approaches. Examples are stops related to the 1919 astronomical observations by Eddington and its implications for the General Theory of Relativity.

In 2016, HBD PRINCIPE, the concessionaire of Sundry Plantation since February 2011, began adapting the Plantation buildings for hotel purposes, and in the process both plaques were moved to the western façade of the old Administration House for purely logistical reasons, as room was needed for an esplanade in the backyard of the building.

In summary, during the second decade of the twenty-first century, the two plaques that mark the astronomical observations of 29 May 1919 at Sundry Plantation (the first installed in 1989 and the second one in 2009), have been sited at three different places within Sundry Plantation (see Figure 6).

In 2019, for the centenary celebrations of the 1919 total solar eclipse the joint organisation *Eddington at Sundry: 100 Years Later* (*Eddington na Sundry: 100 Anos Depois*)

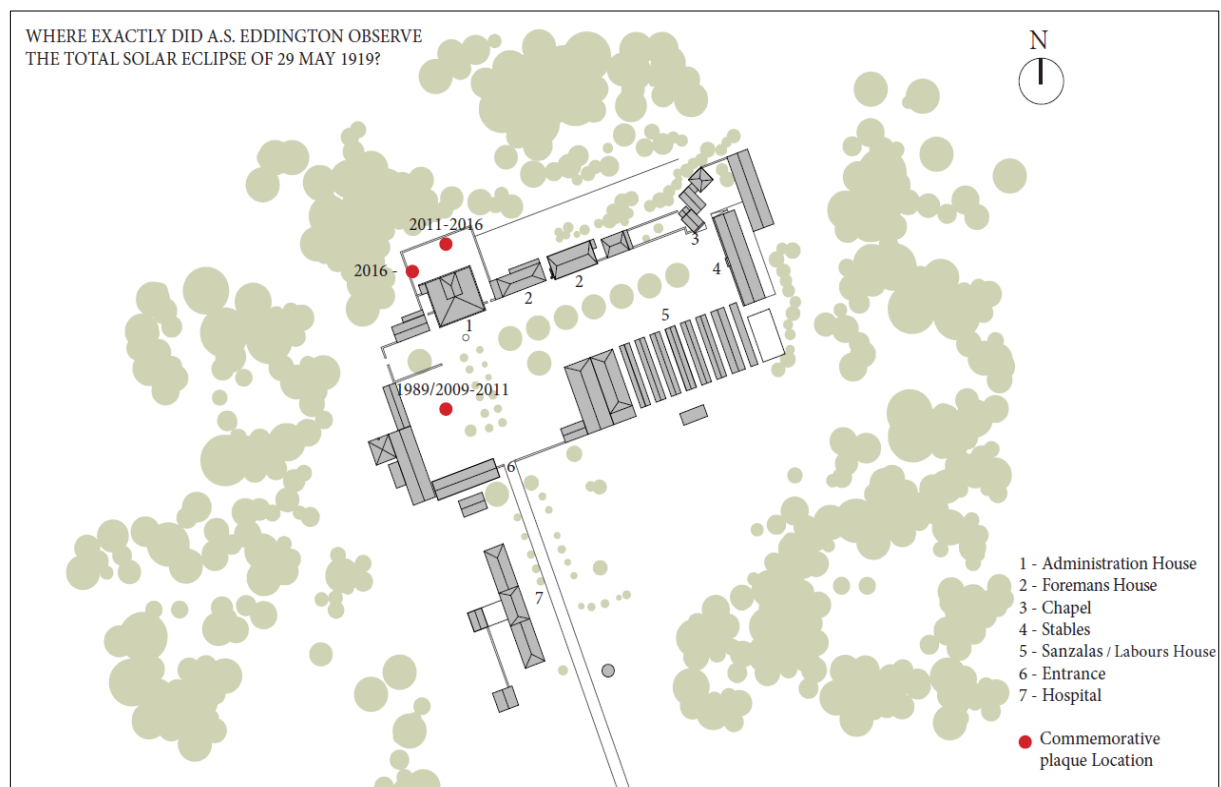


Figure 6: A plan showing the various buildings at Sundry Plantation, and the different locations of the commemorative plaques (plan: Duarte Pape).

(esundy.org), which involved the RGP and several Portuguese and São Tomé e Príncipe institutions, all with a solid history of collaboration, prepared a bold scientific and educational program on a local and global scale. At the local level, it aimed to become the cornerstone for the consolidation of a historical and scientific legacy in São Tomé e Príncipe, most specifically at Sundry Plantation (Latas, 2019).

3 IDENTIFYING THE EXACT LOCATION OF EDDINGTON'S TELESCOPE

Doubts concerning the exact position chosen by Eddington and Cottingham to observe the eclipse persisted despite Polo's research visualized in her artistic rendition of the installation. As such, the identification of this exact position was deemed central to the activities of the centenary celebrations.

A strong interdisciplinary team, including the three authors of this paper, was summoned to examine information stemming from history of science, mathematics, architecture, and anthropology, as well as including as far as possible the memories of members of the community from Sundry Plantation. The final result, marking the correct spot of the observations was signalled by an artistic rendition by a local artist.

The outcome of research unfolded in the context of *Eddington at Sundry: 100 Years Later*, and most specifically in the context of the exhibition *E3. Einstein, Eddington and Eclipse*, which took place in Lisbon at the National Museum of Natural History and Science (MUHNAC – Museu Nacional de História Natural e da Ciência), from 16 May to 8 September 2019, and which centred on an interconnected rendition of the travels of the two British expeditions, their backgrounds and immediate impact, with a special focus on the response from Lisbon. The lack of visual renditions of the installation at Príncipe and its precise location (contrary to what happened in Sobral) was addressed specifically with a view to finding plausible historical solutions to these puzzles (Simões 2019; Simões and Sousa 2019). On Príncipe an astrographic lens (which still exists) loaned by Oxford Observatory was used, along with a 16-inch cœlostát, while at Sobral besides the astrographic lens and attendant 16-inch cœlostát borrowed from the Royal Observatory, Greenwich, there was also a 4-inch telescope (with a 19-feet focus) complemented by an 8-inch cœlostát, which belonged to the Royal Irish Society (Dyson et al., 1920: 295). The installation at Príncipe was probably similar to the one at Sobral, consisting of a tent framework covered by tarpaulins (Figure 7).



Figure 7: The installation at Príncipe was similar with that of Sobral but included just one telescope and a cœlostát, not the smaller telescope and cœlostát marked here with the crosses (Fotobanco Pao7TD; after Simões, 2019: 47).

Besides going back to the 1920 joint paper (Dyson et al., 1920) and Eddington's letter to his mother already taken into consideration by Polo, informal conversations with members of the Sundy community and with anthropologist Rita Alves, who has been studying the community for eight years, helped to identify potential places frequented by the British team, based on the Plantation's daily operations a century ago. Another line of research proved particularly helpful: it concerned the architectural reconstruction of Sundy Plantation, and more specifically the evolution of the Administration House, identifying its architectural features when Eddington and Cottingham stayed there. Taken into consideration with the information stemming from all other sources, it proved crucial when trying to identify the exact location of Eddington's telescope.

The place to start was, of course, the 1920 paper, which included the approximate coordinates of the observing site:

Our telescope was erected in a small walled enclosure adjoining the house, from which the ground sloped steeply down to the sea in the direction of the sun at eclipse. On the other side it was sheltered by a building. The approximate position was latitude 1° 40' N, longitude 29m 32s E [= 7° 23' 00" E] (Dyson et al., 1920: 313).

In the letter to his mother Eddington described vividly the location of Sundy Plantation and the spot where they positioned the telescope:

The house is near the north-west corner of the island, away from the mountains, and on a plateau overlooking a bay about 500 feet below. We had noticed this house as we approached the island on the steamer. There was little difficulty in deciding that this was the most favourable spot; and there happened to be an enclosed piece of ground close to the house which just suited us. We look straight on to it from our bedroom window. It is sheltered on the east by a building and is open towards the sea on the west and north — just right for the eclipse. We arranged to have a small pier built for the coelostat to stand on, and to have our belongings brought over on Monday.⁶

The few memories of Sundy's inhabitants relating to the 1919 eclipse called attention to the evolution of the construction of the buildings and their different functions, and to the possibility that Jerónimo José Carneiro observed the eclipse from the third window on the second floor of the Foremans House (Casa dos Encarregados), where the office, drivers' rooms and manager room were also located. This last memory is compatible with Eddington's letter, cited above, in which he lists all people, including Carneiro, who joined the British team for the observation of totality.

The urban and architectural evolution of Sundy Plantation can be traced through cartographic and photographic records, as well as through information concerning the various processes used in the construction of the buildings.

Sundy Plantation probably started as a place of worship and pilgrimage, during a period of strong control of the island and of Brazilian farmers by the Catholic Diocese. Its oldest construction was a small seventeenth century chapel, invoking our Lady of Penha. It evolved into a poorly defined urban structure, with the installation of a small agricultural facility owned by José Rodrigues Pedronho and his family. This facility operated until 1875, when it was acquired by Jerónimo Carneiro, the father of the Plantation's owner at the time of the eclipse, whose name, as we know already, was Jerónimo José Carneiro. His father transformed Sundy Plantation into one of the most important productive units of the island, known internationally for its cocoa. Sundy progressed into an urban structure organized around an open rectangular courtyard (*terreiro*), nowadays over 240 meters long and 60 meters wide, and containing different hierarchies of spaces and buildings. The main entrance to Sundy Plantation, along the courtyard, was aligned with the Administration House, as it is presently. However, a century ago the courtyard was smaller, and the Administration House was flanked by two wooden warehouses, which have been demolished in the interim (see Figure 8).



Figure 8: Various pictures of the courtyard aligned with the Administration House (Main House) (third picture from the left), and other buildings existing at Sundy in 1989 (courtesy: IDL Archive Amaro da Costa Institute – Inventory of Agricultural Companies of São Tomé e Príncipe 1989).



Figure 9: Railway hangar in Sundry (courtesy: Jerónimo Carneiro Family Archives).



Figure 10: Rails and locomotive in Sundry courtyard (courtesy: Jerónimo Carneiro Family Archives).



Figure 11: The first hospital of Sundry plantation (courtesy: Jerónimo Carneiro Family Archives).

After the first two decades of the twentieth century, Sundry Plantation included the Administration House, at the opposite end of the chapel, the railway hangar (Figure 9), the Off-

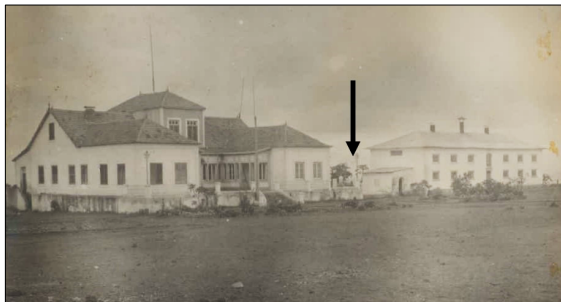


Figure 12: A photograph of the Administration House in 1919, with the arrow indicating the suggested location of Eddington's telescope (courtesy: Jerónimo Carneiro Family Archives).

ices Building (1912) to the west, and the Foreman's House (the exact date is still unknown) to the east, the building where European workers or higher hierarchy workers stayed. In 1915, the batteries of houses (*sanzalas*) for contract workers were built,⁷ diametrically opposite to the Administration House, and clearly separating the living space of workers from the administrative area and the main building of the Plantation. The decauville (narrow gauge) railroad tracks (Figure 10) used for transporting goods and workers crossed the entire yard, linking the plantation area, and other facilities to the city of Santo António, via the main entrance access.

The old hospital (Figure 11), whose construction date is still unknown, is a sign of modernity and compliance with health and sanitary issues, and is located outside the courtyard, certainly due to the imposition of regulations issued in the first decades of the twentieth century.

Afterwards the stables were built (in the 1930s), with their iconic castle-like features, and the school, electric dryers, workshops, and a new hospital, among other facilities.

Going back to the Administration House (the Main House), by following in detail the various renovations and enlargements that it went through, we were able to locate with great precision the site where Eddington's telescope was positioned and where totality was observed back in 1919.

The original version of the Administration House (Figure 12), which was in place in 1919, was a two-storey H-shaped building, accessed by a patio and exterior staircase, with the second floor on its central part. On the lower floor Jerónimo José Carneiro's office was located to the west, and guestrooms or rooms for family members to the east, with a backyard reserved for sanitary areas, kitchen, and dining area. The master bedroom, where the owner slept, was located on the upper floor, with a view to the south across the courtyard and to the north out to the sea.

Jerónimo José Carneiro was an educated and respected member of the elite of São Tomé e Príncipe, who accompanied the British astronomers from the time of their arrival in Príncipe and offered to house them at Sundry Plantation. Due to their social standing, it is certain that Eddington and Cottingham stayed in the Administration House and not in the Foreman's House (which was reserved for European workers of lower status than the Englishmen). Only the Main House was suitable for such distinguished visitors.

Between the Administration House and the Foreman's House to the east, there was a small garden, on a flat piece of land, protected by the two buildings and therefore located in the plantation's 'administrative area', far from the sanzalas of the manual workers' residential area. We believe that this was where Eddington's telescope was located (see Figure 12).

Let us explain the successive steps in our interdisciplinary reasoning. The latitude $1^{\circ} 40' N$ listed in the 1920 research paper, without specification of arc seconds, together with the longitude expressed with the same uncertainty, is clearly insufficient to identify the probable geographical location of the telescope as this amounts to an uncertainty in latitude of about ± 2 kilometres, and an uncertainty in longitude that is likely to be larger. The only way to arrive at an unequivocal location results from cross-referencing this information with both the data contained in Eddington's 1919 letter to his mother, the architectural features of the Administration House in 1919, and the knowledge of the dimensions of the area covered by the Administration House and the Foreman's House

(the rectangle of about 20m by 50m depicted in Figure 14). When one does so on Google Earth one arrives at the following coordinates for the observing site: latitude $1^{\circ} 40' 13'' N$, and longitude $7^{\circ} 23' 00'' E$. This spot meets all three criteria stemming from the printed and manuscript sources and knowledge of the architectural features of the Administration House: 1) the telescope is seen from the bedroom window located on the east side of the Administration House; 2) the Foreman's House is to the east; and 3) the observing site is open towards the sea to the west and the north (see Figures 13, 14 and 15).

In order to signal the right location where the observations of totality took place during the 1919 eclipse it was recommended that HBD PRINCIPE build a circular platform for a telescope, and this suggestion was immediately endorsed and carried out. The Santomean artist Eduardo Malé then used it as the basis for an artistic interpretation of the phenomenon of light deflection (Figure 16). All was ready in time for the 29 May 2019 celebrations.

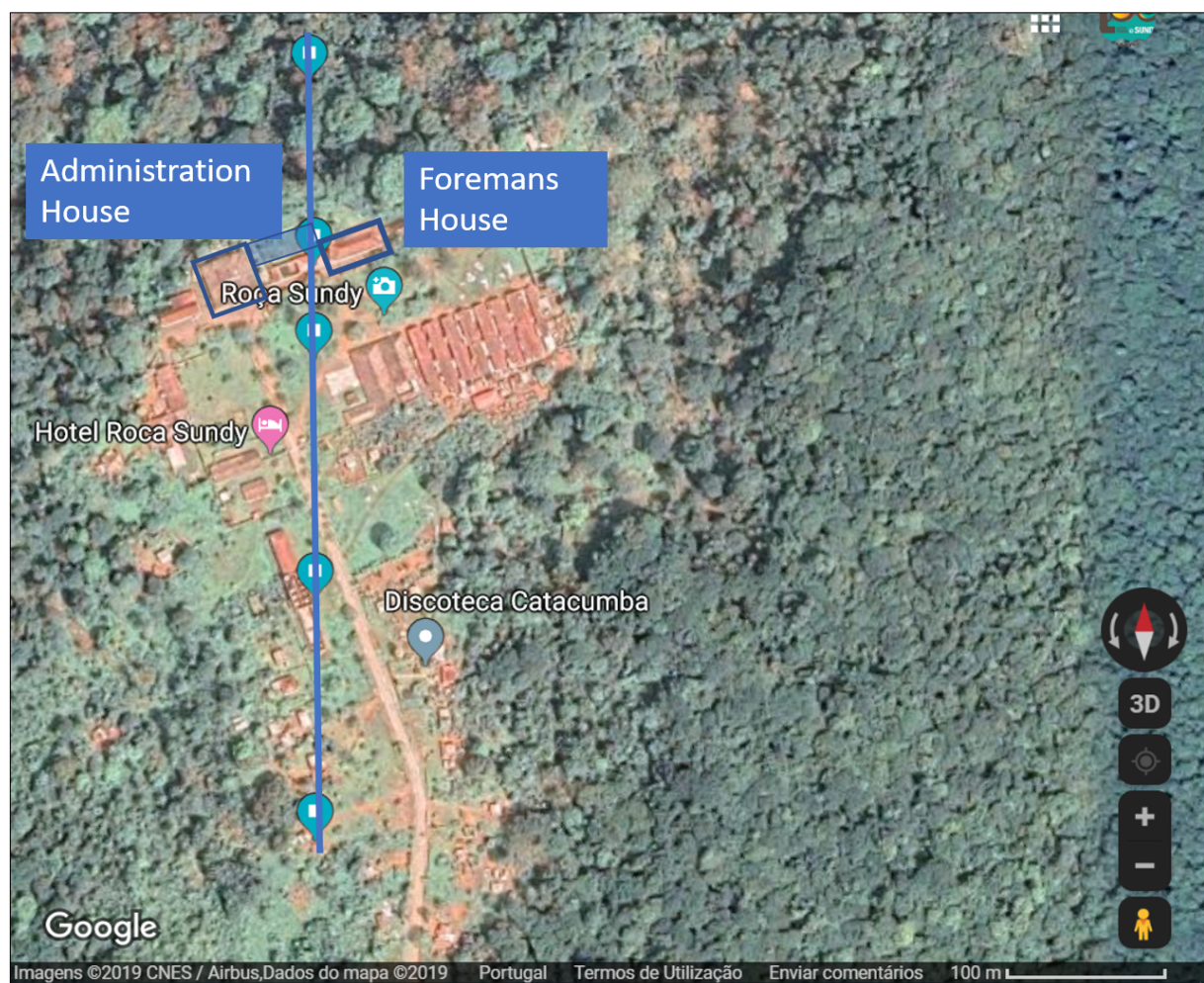


Figure 13: Possible locations for the telescope given the longitude stated in the 1920 paper, and by varying the latitude along the $1^{\circ} 40' N$ line (Google Earth; map modifications: Joana Latas).

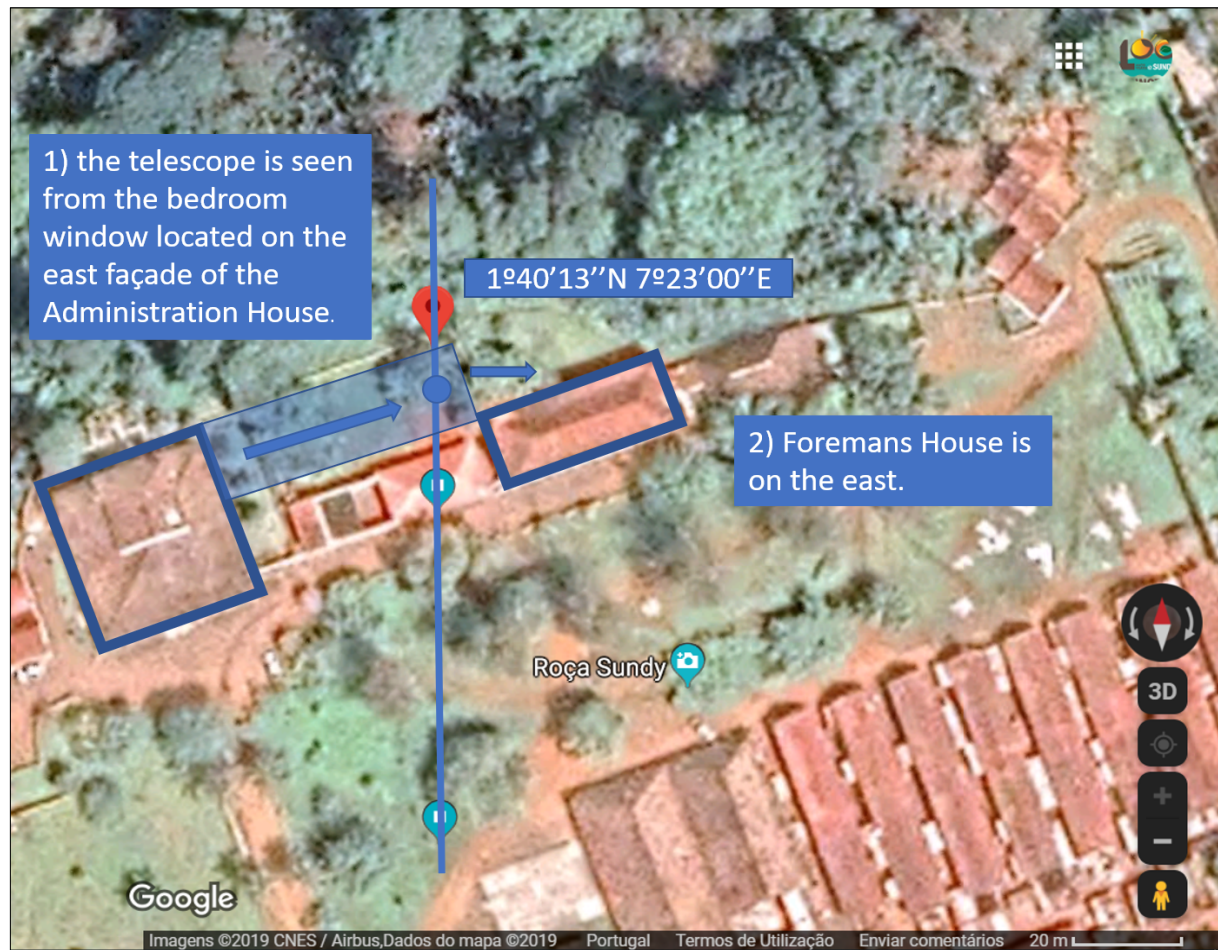


Figure 14: A close-up showing the location of the 1919 observing site (the blue dot) in relation to criteria 1) and 2) mentioned in the text (Google Earth; map modifications: Joana Latas).



Figure 15: A map of part of Príncipe showing the location of the 1919 observing site in relation to criterion 3) mentioned in the text (Google Earth; map modifications: Joana Latas).

In addition, for educational purposes, the platform became a station in the Science Trail, in which the history behind the 29 May 1919

astronomical observations could be explored. The platform was also conceived in such a way as permitting its enlargement in the near

future to allow for telescopic observations of the night sky, thereby enhancing the cultural and scientific value of Sundy Plantation as an astro-touristic destination.

4 CONCLUDING REMARKS

This research paper discussed the convoluted process that led to the identification of the location of the telescope with which Eddington and Cottingham made their famous observations during the total solar eclipse of 29 May 1919. Research involved approaches using history of science, mathematics, architecture and anthropology. Furthermore, besides the intrinsic value of interdisciplinary research, this identification had strong implications for the dissemination of science in Príncipe. It reinforced the strategy of HBD PRINCIPE by valuing the scientific past of Sundy Plantation, as well as the vision of the President of the Autonomous Region of Príncipe, which centred on empowering local communities while boosting their development through scientific education and communication. Enhancing the collective memory of such a ground-breaking scientific event definitely plays a central role in this process, while offering the prospect of many promises.

5 NOTES

1. Sundy in *forro*, one of the Santomean dialects, means Mr Dias, the name of the Plantation's first owner. The name Sundy appears on most maps and in written documents of the colonial period until the middle of the twentieth century. However, for the sake of local and Portuguese phonetics, it often appears as 'Sundi'.
2. According to the *Boletim da Agência Geral das Colónias*, the population of Príncipe was 5311 in 1914 and 6903 in 1921. Simões and Sousa (2009) estimated that the population of Príncipe was 6000 in 1919. Regarding Príncipe's current population, the official demographic estimate by the National Institute of Statistics of São Tomé and Príncipe for 2020 is 8700 inhabitants.
3. Admiral Gago Coutinho was an expert colonial geographer and cartographer who became a well-know public figure and national hero after his pioneering flight across the South Atlantic, from Lisbon to Rio de Janeiro, with colleague Sacadura Cabral, in 1922.
4. Named the Administration House, this was the main building at the Plantation, where the owner's family lived and where his office was located.
5. HBD, or 'Here Be Dragons', is an expression that often was used by cartographers in the eighteenth century in association with the illustration on maps of unknown geographical areas with monsters and other mythological creatures. As such, dragons symbolized the potential dangers hidden in these unknown places, and the expression 'HBD' refers to an unexplored and, therefore, mysterious geographical area.
6. Trinity College Archives, Eddington Correspondence, Letters from A.S. Eddington to Sarah Ann Eddington. Letter of 29 April - 2 May 1919.
7. The modernization of workers' houses was regulated in Article 106 of the General Regulation of 17 July 1909.



Figure 16: The circular base about 1.5m in diameter marking the correct location of Eddington's telescope (May 2019). The painting is from Santomean artist Eduardo Malé (Courtesy: Eddington at Sundy).

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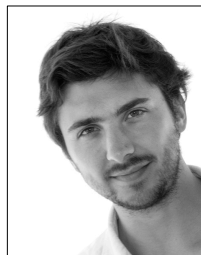
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