

Eddington at Sundry: From History to Legacy

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Eddington at Sundry: 100 Years Later celebrated the centenary of the observations of the 1919 solar eclipse, a landmark event that resulted in the first experimental confirmation of Einstein's General Theory of Relativity. This celebration was recognized by the International Astronomical Union (IAU) as a milestone event for their centenary celebration. More than 50 institutions contributed to nearly 100 initiatives developed in different formats, climaxing in an intense programme experienced by hundreds of people at the Roça Sundry landmark on Príncipe Island at the end of May 2019. Like the 1919 expeditions, three continents were directly involved in these celebrations, showing that international collaboration can result in a sum greater than its parts, leaving a legacy that will prevail for many years to come.

Introduction

On 6 November 1919, in a session of the Royal Astronomical Society, three renowned British astronomers presented the report of two expeditions, one to Sobral, Brazil, and one to the island of Príncipe, a then-colony of Portugal. The goal of the expeditions was to observe the total solar eclipse of 29 May 1919 and test one of the predictions of the then-recent general theory of relativity: that light would deflect due to mass. In their conclusions, the astronomers, Sir Frank Watson Dyson, Arthur Stanley Eddington and Charles Rundle Davidson, were emphatic: 'Thus the results of the expeditions to Sobral and Príncipe can leave little doubt that deflection of light takes place in the neighbourhood of the Sun and that it is of the amount demanded by Einstein's generalized theory of relativity, as attributed to the Sun's gravitational field' (Dyson, Eddington & Davidson, 1920).

Einstein's General Theory of Relativity has been acclaimed as one of the most fruitful theories in science. The applications of the theory have ranged from the orbital movement of Mercury around the Sun to the structure of black holes to the shape of the universe to gravitational waves, both recognized with Nobel Prizes. However, its impact can also be seen in our daily

life. Relativistic effects play a crucial role in determining precise locations and exact timing via global navigation satellite systems such as the American Global Positioning System (GPS) and European Galileo.

The discovery itself is also a story of resilience. The observation occurred just after World War I. However, the preparation that started two years before was held back by the lack of specialized manpower, old instrumentation that was ill-adapted to this monumental experiment, and continental division. However, the collaborative pursuit of scientific overcame these restrictions.

The transcontinental effort across London (Europe), Príncipe (Africa), and Sobral (South America), and its magnificent history and results inspired Eddington at Sundry: 100 Years Later (E@S). Despite the difficulties a layperson has in understanding General Relativity and the full scientific topics encompassed, the dozens of collaborators and institutions involved in the celebration prepared and implemented activities with care and enthusiasm to produce a rewarding and successful experience. Now, the legacy – Espaço Ciência Sundry (Sundry Science Space) – will guarantee that the celebration will materialize into a long-lasting vision to change and enrich the community.

Strategy and Implementation

E@S brought together people from diverse backgrounds to celebrate the centenary of the 1919 solar eclipse under a unified vision¹ challenged by an organizational team including the Regional Government of [the Island of] Príncipe, Santomean and Portuguese universities, and educational and science outreach institutions. This was accomplished through international communication channels among various public groups and the cultural impact of the 1919 solar eclipse in São Tomé and Príncipe.

The E@S programme took place between 14 April, 2018 and 30 November, 2019, with nearly 100 events about science, history of science, science education, and science communication.

From May 24 to 29, 2019, the island of Príncipe hosted the culmination of the E@S celebrations, with 35 events in ten different locations around the island.

The six-day programme balanced public interests, expectations, and cultural inputs from residents and visitors with the available resources across the island. Before this 'main event in Príncipe' – as we will call it – a pre-event in January 2019 allowed us to listen to the local community,

gather their views and expectations, and establish important collaborations.

Resilience and trust built between the international organising committee and the local commission in Príncipe proved fundamental to the management of available resources in an environment that rarely holds international events like E@S. For example, about a month before the main event, a deadly shipwreck in the crossing between São Tomé and Príncipe, and a fire in another boat in the São Tomé harbour caused concern about the timely arrival of goods and fuel for the event.

Communication and coordination were key to the success of E@S. In fact, the interlinking between concepts, activities, institutions, people, and places was crucial to ensure the global coherence of the celebrations.

Communication was used to strategically promote an interest in science using a two-way dialogue between society and science, which recognized mutual benefits for different audiences (Trench, 2008). Consistent with this model of science communication, we highlight four principles that were present in the development of E@S actions: i) co-creation, ii) interactions, iii) network, and iv) glocal.

Co-creation

The Global Science Opera (GSO)² is a collaborative project that brings scientific and artistic inquiry into schools through

a process of virtual interaction between students from different countries. The 2019 GSO Gravity honoured the 1919 expeditions.

The main story of Gravity resulted from a five-month online collaboration between students and teachers from schools of both islands of São Tomé and Príncipe, Campos, and Sobral in Brazil, and Porto in Portugal, with support from artists, musicians, scientists, computer programmers, and other specialists from different fields. This format allowed participants to actively discuss and negotiate during production. The diverse array of participants enriched the production's storyline with diverse interpretations of 'gravity', from Einstein's General Theory of Relativity to today's advanced knowledge of gravitational waves.

The performance was broadcasted on 29 May 2019 during the main E@S event in Príncipe (Figure 1). The world premiere took place in November 2019 with the participation of more than 20 countries.

Interactions

The interactions between scientific knowledge and society were also established through the Trilho da Ciência (Science Trail), a nature walk that explores the universe through 'stations' which explain the science of the surrounding environment (Figure 2). The trail concept was inspired by the 1919 eclipse observations and the designation of Príncipe as a UNESCO

World Biosphere Reserve³ and bridged implicit and explicit representations of scientific knowledge in an environment familiar to local community members. Each station engaged participants through touch, cognition, and emotion ('hands-on, minds-on, hearts-on') creating a fully interactive knowledge-sharing experience for both audiences and specialists. In this Trilho da Ciência, scientists and teachers from the Príncipe High School iteratively worked together to design some stations of the trail.

The Trilho da Ciência was also used in teacher training organized by the Portuguese Language Office of Astronomy for Development (PLOAD)⁴ with representatives from five Portuguese-speaking countries and members of the PLOAD and science teachers from Príncipe.

In addition, the concept of the Trilho da Ciência was presented in the exhibition 3E - Três Eclipses (3E - Three Eclipses)⁵ an exhibition of the 1914, 1919, and 2013 total solar eclipses produced by the Science Museum of University of Coimbra, Portugal.

Network

The growing credibility of the E@S project was reflected in the participation by the international scientific community. The network of astronomers and other science specialists who, individually or institutionally, supported the celebration and participated in the main event on Príncipe, and enriched the celebration



Figure 1. Performances of the 2019 Global Science Opera Gravity by students of Príncipe High School and Portuguese School of São Tomé and Príncipe on 29 May 2019 at the Roça Sundy landmark on Príncipe Island. Credit: Marina Balbina



Figure 2. Trilho da Ciência (Science Trail) station 'Why do eclipses occur?' taught by Joyn Tioló, teacher at Príncipe High School. Credit: Marina Balbina



Figure 3. In a manifestation of culture, actors perform an excerpt from the Príncipean play *Auto de Floripes* near the entrance of Espaço Ciência Sundry (Science Space Sundry). Credit: Valente Cuambe



Figure 4. Videoconference *Príncipe e Sobral 100 Years Later*. On the Príncipe side, seated left to right are the Jorge Bom Jesus, Prime Minister of São Tomé and Príncipe; José Cassandra, President of the Regional Government of Príncipe; Aires Bruzaca, Dean of the Public University of São Tomé and Príncipe; IAU President Ewine van Dishoeck; and José Sande Lemos, President of the Center for Astrophysics and Gravitation (CENTRA). Each delivered a speech during the videoconference. Credit: Maique Madeira

with their networking and knowledge sharing. Interactions between individuals in different arenas consolidated the E@S network and brought different perspectives to the E@S actions.

E@S was recognized by the International Astronomical Union (IAU) as a Milestone project in their own centenary celebration, IAU100. IAU President Ewine van Dishoeck and IAU General Secretary Teresa Lago attended the main event in Príncipe to show support from the IAU100.

The international conference *From Einstein and Eddington to LIGO: 100 Years of Gravitational Light Deflection*⁶, held in Príncipe between 26-28 May 2019 promoted a face-to-face collaboration between fifteen prestigious experts. They were invited to discuss, share, and reflect on scientific development in Relativity-related topics over the last century (Lemos *et al.*, 2019).

Relationships were also established between members of the scientific community and the media, resulting in a number of productions, namely the documentary *À Espera das Estrelas (Waiting for the Stars)*⁷ produced by RTP Africa.

Glocal

In the same place that Eddington and Cottingham chose to observe the eclipse on 29 May 1919, the Roça Sundry received more than five hundred visitors exactly a hundred years later. About a hundred were scientists, educators, science

communicators, along with other official guests and representatives of partner institutions.

Community members, local students and teachers, visiting researchers, and guests connected through activities throughout the landmark's campus. Traversing between the global and local dimensions created a place for cultural moments, such as the honouring of literary and musical contributions by the Príncipe diaspora, and discussions of gravitational waves between high-level specialists in culture and science (Figure 3).

Through videoconference, public authorities and scientists in Príncipe and Sobral talked, which strengthened their ties (Figure 4). A British historian of

science spoke with the people of Príncipe next to the telescope used during the 1919 expedition to Sobral. From Príncipe to the world, impressions and interpretations about science, history, and culture were shared.

Moreover, the inauguration of the Espaço Ciência Sundry (Sundry Science Space) marked the political commitment of São Tomé and Príncipe to global science and the historical location (Figure 5).

E@S achieved its goal of a global celebration for one of the most important discoveries of the 20th century, and in turn built links among people across the globe and placed the foundation stone of a new era of science and education for the island.



Figure 5. Unveiling of the inaugural plaque of Espaço Ciência Sundry (Science Space Sundry) by the presidents of São Tomé and Príncipe and Portugal in the presence of the President the Autonomous Region of Príncipe and the Minister of Foreign Affairs of Equatorial Guinea. Credit: Maique Madeira

Legacy

The E@S legacy has been materialized through Espaço Ciência Sundy. This non-formal educational setting was developed by an interdisciplinary team and aims to embody the link between history and science, safeguarding the legacy of a major scientific event. This space broadens the range of science education options on Príncipe beyond what is currently supported in the school infrastructure. The space will also stimulate initiatives in training and innovation in responsible tourism, in line with the development plan of Príncipe⁸ with the aim of improving the residents' quality of life (Latas, 2019). To bolster local development, a planetarium was constructed in this space at the end of March 2020. Although there is no public opening date due to the COVID-19 pandemic, this planetarium will be the first in the country and one of the few on the west coast of Africa.

Additionally, the media of E@S have won awards in the months following E@S. RTP Africa received the international Harambee Communicate Africa prize for the Terra Príncipe episode 'Jewels of Príncipe'⁹ and the comic Einstein, Eddington, and Eclipse – Travel Impressions (Simões & Sousa, 2019) received a Portuguese 2019 Comics Award prize.¹⁰

In addition to these awards, but no less important, the organizational division into independent, remote teams has established new collaborations beyond the E@S context. These initiatives are still ongoing.

Final Remarks

Eddington at Sundy: 100 Years Later united hundreds through one eclipse one hundred years after a landmark experiment. The unique celebration brought together scientists, artists, politicians, educators, students, families, and community members to commemorate the interactions of science, history, diversity, society, and culture across borders. The event is a testimony of the importance of the observations, and its legacy will continue on the island of Príncipe.

Notes

¹ Vision for Eddington at Sundy webpage: <https://esundy.org/index.php/en/about-es/vision/>

² Global Science Opera website: <https://globalscienceopera.com/>.

³ UNESCO webpage of the UNESCO World Biosphere Reserve on Príncipe: <https://en.unesco.org/biosphere/africa/island-of-principe>

⁴ Portuguese Language Office of Astronomy for Development (PLOAD) website: <http://pload.org/>

⁵ The 3E - Três Eclipses exhibition and other E@S activities are further explained on the E@S website: <https://esundy.org/index.php/en/homepage/>.

⁶ From Einstein and Eddington to LIGO: 100 Years of Gravitational Light Deflection Conference website: <https://science.esundy.tecnico.ulisboa.pt/en/>

⁷ The documentary, in Portuguese, is available at <https://www.rtp.pt/play/p5865/espera-das-estrelas>. The collection of resources produced by RTP Africa within the scope of Eddington @ Sundy are available at <https://esundy.org/index.php/es-na-imprensa/>.

⁸ Príncipe 2030 official website: <https://www.principe2030.com/>

⁹ Harambee Communicate Africa prize announcement: <https://harambee-portugal.org/comunicar-africa/premio-comunicar-africa/>

¹⁰ 2019 Prémios Bandas Desenhadas comic awards announcement: <https://bandasdesenhadas.com/2020/04/24/premios-bandas-desenhadas-2019-os-vencedores/>

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Biographies

Joana Latas is currently a PhD researcher in the History of Science and Scientific Education at the University of Coimbra. She is also active in international networks in the areas of mathematics education and astronomy for development. Recently, she coordinated Eddington at Sundy: 100 Years Later project (esundy.org).

Maria José dos Prazeres is currently the Director of Environment and Nature Conservation on Príncipe Island. She graduated from the University of Lisboa and since 2013 she has taught mathematics at Príncipe High School. Maria José coordinated the Local Organizing Committee for the Eddington at Sundy: 100 Years Later project on Príncipe Island.

Rosa Doran is a science educator devoted to the integration of modern trends for innovation in the classroom, with a special emphasis on the use of astronomy for STEAM learning. She received a PhD in Science Education from the University of Coimbra in 2020 and holds leadership positions in a number of international astronomy research and outreach organizations.

João Fernandes is an astronomer and Assistant Professor in the Mathematics Department at the University of Coimbra. He received a PhD in Astrophysics from the University of Paris in 1996 and habilitation in Physics/Astrophysics from the University of Coimbra, in 2014. He was the Portuguese SPOC for the International Year of Astronomy 2009.