

# TOWARDS A GLOBAL HISTORY OF THE ECLIPSE OF 29 MAY 1919

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**CIUHCT**

Centro Interuniversitário de História  
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BSHM GRESHAM LECTURE  
LONDON, 23 OCTOBER 2019

THE CONTEXT

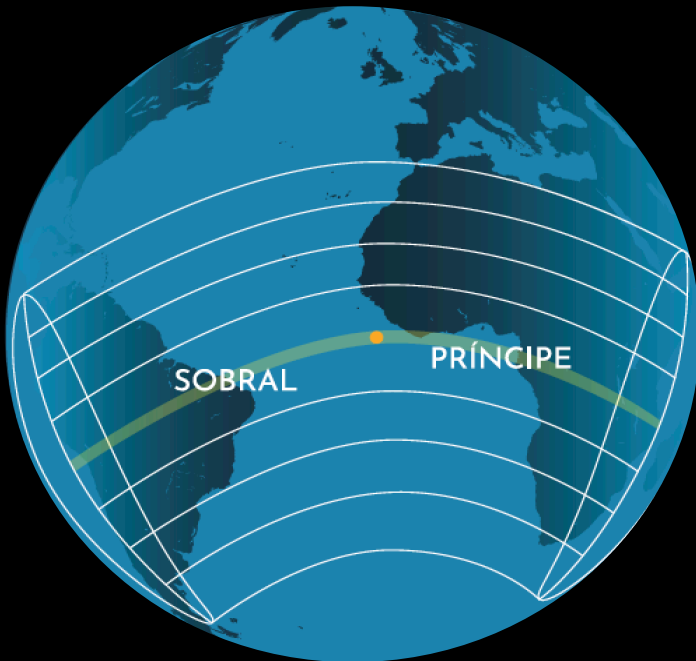
THE ARGUMENT

TO BE OR NOT TO BE: OBSERVING TOTALITY

TO DEPICT OR NOT TO DEPICT: WHEN VISUAL  
RECORDS SPEAK

BRAZIL' S PRESENCE, PORTUGAL' S OMISSION

CONCLUDING REMARKS





THE CONTEXT

A.S. Eddington



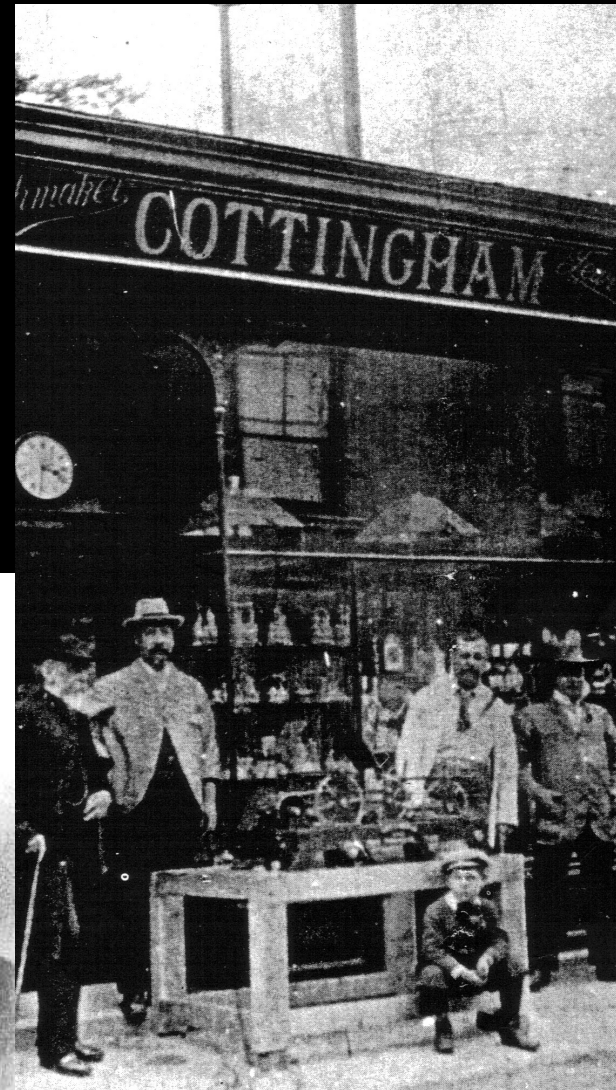
C.R. Davidson



A.C. C.  
Crommelin



E.T. Cottingham



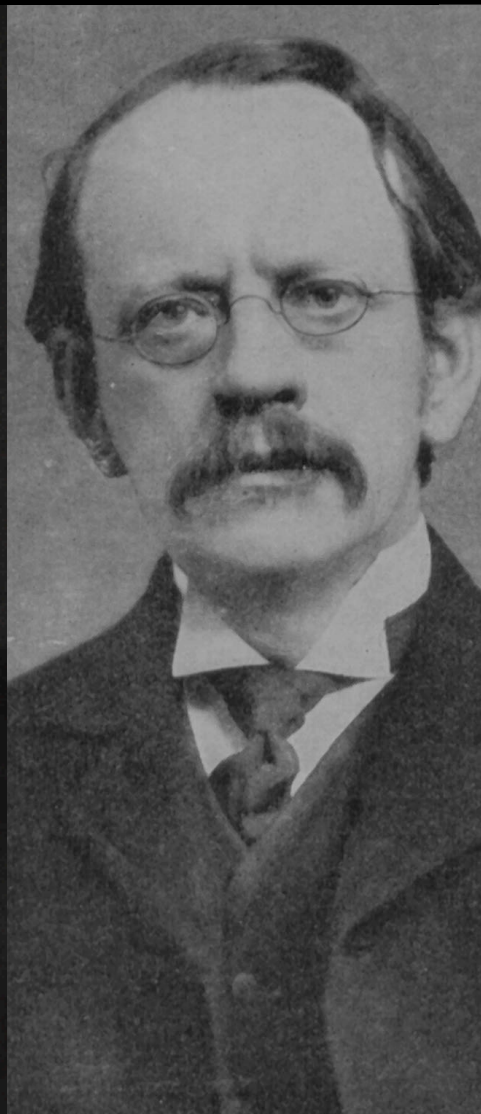
A. Einstein



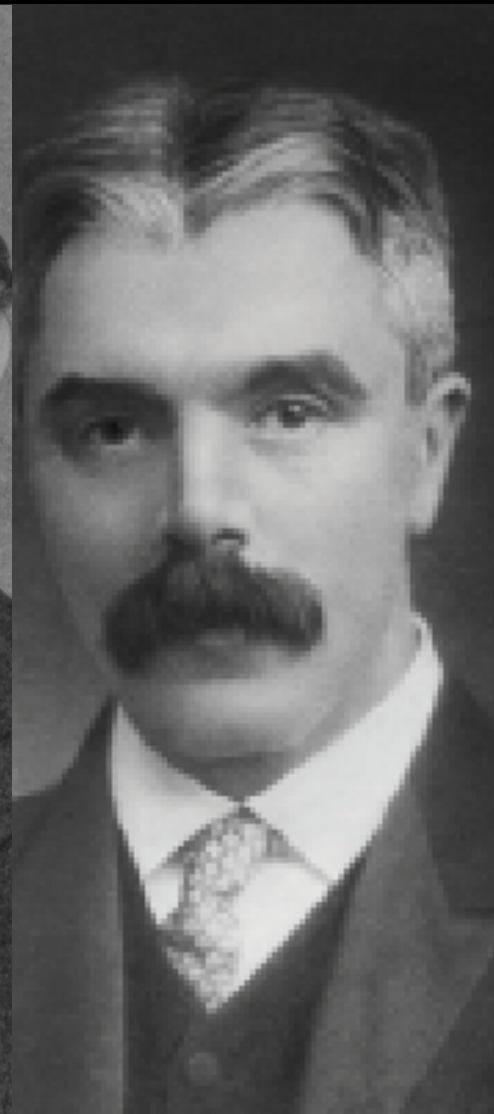
A.S. Eddington



J.J. Thomson



F.W. Dyson





Fundo de estrelas, incluindo ao centro a constelação Touro e o enxame das Híades observado durante o eclipse de 29 de Maio de 1919. Adaptação de H.A. Rey, *The Stars. A new way to see them*, 1980, p. 43.

Foto do Eclipse

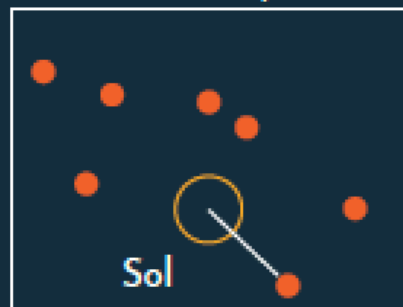
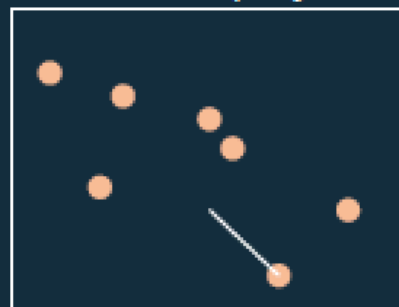
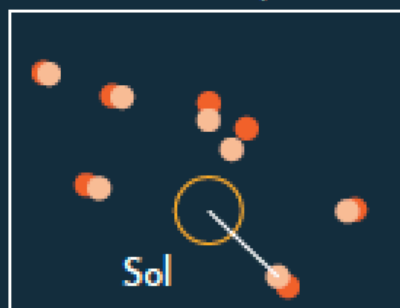


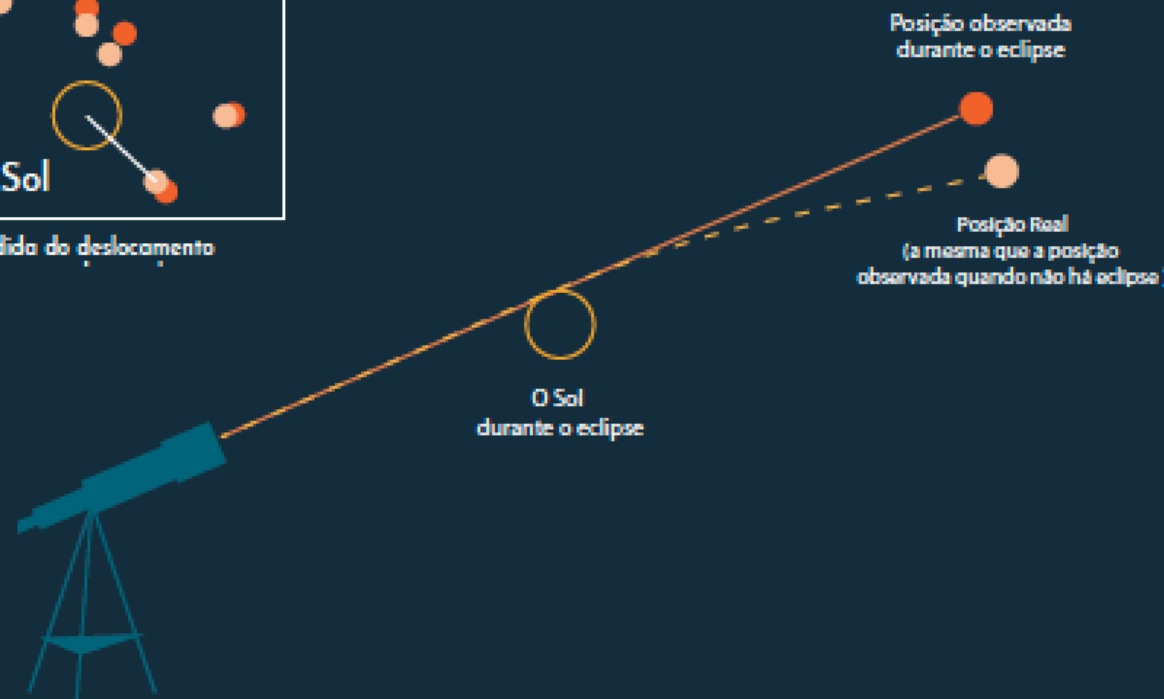
Foto de comparação



Comparação das fotos com  
os necessários ajustes



Medida do deslocamento



IX. *A Determination of the Deflection of Light by the Sun's Gravitational Field, from Observations made at the Total Eclipse of May 29, 1919.*

*By Sir F. W. DYSON, F.R.S., Astronomer Royal, Prof. A. S. EDDINGTON, F.R.S., and Mr. C. DAVIDSON.*

*(Communicated by the Joint Permanent Eclipse Committee.)*

Received October 30,—Read November 6, 1919.

[PLATE 1.]

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I. PURPOSE OF THE EXPEDITIONS.

1. THE purpose of the expeditions was to determine what effect, if any, is produced by a gravitational field on the path of a ray of light traversing it. Apart from possible surprises, there appeared to be three alternatives, which it was especially desired to discriminate between—

- (1) The path is uninfluenced by gravitation.
- (2) The energy or mass of light is subject to gravitation in the same way as ordinary matter. If the law of gravitation is strictly the Newtonian law, this leads to an apparent displacement of a star close to the sun's limb amounting to  $0''.87$  outwards.
- (3) The course of a ray of light is in accordance with EINSTEIN's generalised relativity theory. This leads to an apparent displacement of a star at the limb amounting to  $1''.75$  outwards.

In either of the last two cases the displacement is inversely proportional to the distance of the star from the sun's centre, the displacement under (3) being just double the displacement under (2).

It may be noted that both (2) and (3) agree in supposing that light is subject to gravitation in precisely the same way as ordinary matter. The difference is that, whereas (2) assumes the Newtonian law, (3) assumes EINSTEIN's new law of gravitation. The slight

Einstein  
deviation of  $1.75''$  seconds of arc

Newton  
deviation of  $0.87''$  seconds of arc

# THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

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VOL. XL.

APRIL, 1917.

No. 512.

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MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, 1917 March 9.

*The President.* We will return our thanks to Mr. Reynolds, and I will now call on the Astronomer Royal to give his paper "On the Opportunities afforded by the Eclipse of 1919, May 28, of verifying Einstein's Theory of Gravitation."

THE ARGUMENT



In this talk, I change the focus of analysis from the astronomical, physical and mathematical pillars of Einstein's prediction and the expeditions' impact in proving general relativity theory, already discussed at length in the literature.

I opt instead for a joint discussion of the two expeditions in order to show that their scientific consequences - astronomical, physical and mathematical – were grounded on a number of people, events, and decisions, which are often bypassed in standard narratives, and which are essential, although often invisible, to the success of the scientific enterprise.

TO BE OR NOT TO BE.

OBSERVING TOTALITY

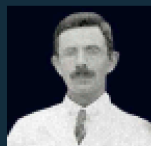
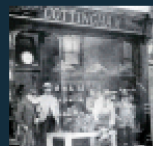
# A VIAGEM

As expedições foram, e continuam a ser, centradas na construção e consolidação do conhecimento através da ciência e poder, economia e política; deslocam pessoas, instrumentos e objectos, em movimentos dominados por peripécias e contratempos inesperados; e, apesar do cuidado cirúrgico posto na sua preparação, estão sempre sujeitas a incertezas que testam a tenacidade dos expedicionários mais teimosos.

As duas expedições britânicas organizadas para observar o eclipse solar total de 29 de Maio de 1919 e testar a previsão de Einstein, não fugiram à regra.

Envolveram quase dois anos de preparativos em tempo de guerra, que culminaram em 5 minutos de observações sujeitas às partidas do tempo meteorológico; apesar do apoio financeiro do governo britânico, o rigor das medições dependeu de instrumentos adaptados de partes pré-existentes, dispersas por várias observatórios britânicos e recolhidos no Observatório Real de Greenwich para os preparativos finais; fizeram deslocar cerca de 2 toneladas de material cada, para regiões tropicais junto ao equador, situadas a distâncias de 7000 km, no caso do Sobral, e de 5800 km, no caso do Príncipe; o seu sucesso dependeu da participação de astrónomos das patrias envolvidas, no caso Portugal e Brasil, de membros das elites locais, mas também de trabalhadores que ficaram para sempre anélmicos.

O encurvamento previsto por Einstein era de cerca de 1,75" segundos de arco e corresponde ao ângulo subtendido por um segmento de 9,5cm observado a uma distância de cerca de 3km; nas chapas fotográficas correspondia a um comprimento de 1/60mm que, ainda assim, estava ao alcance da perícia dos astrónomos; algumas das chapas fotográficas não registaram um número mínimo de estrelas e o tratamento estatístico dos resultados foi o melhor possível nas circunstâncias.



FUNCHAL

LIVERPOOL

LONDRES

LISBOA

CABO VERDE

23 MARÇO 1919  
Chegada à cidade de Belém,  
na entrada do Pará.

BELÉM

CAMOCIM

FORTALEZA

MANAUS

SOBRAL

PRÍNCIPE

FAIXA DE TOTALIDADE

- Viagem Londres - Funchal
- Viagem Funchal - SOBRAL
- Viagem Funchal - PRÍNCIPE



We were ready to take the first photographs about May 16, and as the nights were generally clear we had no difficulty in getting the check photographs. These had to be taken between 12.30 and 1 a.m.; we took them on three different nights. The developing also had to be done at night and, owing to the special difficulties due to the high temperature of the water ( $78^{\circ}$ ), was a slow business. So we were often up pretty late during this period. In the day time I had a good deal of work measuring these check photographs.

The last heavy rain fell about May 9 and shortly afterwards the Gravana or cool season began. There was practically no rain, but a good deal of cloud in the day-time, and the conditions seemed rather less favourable for the eclipse than during the rainy season. However there were a number of beautifully clear days, and usually at least part of the day was clear. The two days before the eclipse were about the most unfavourable we had.

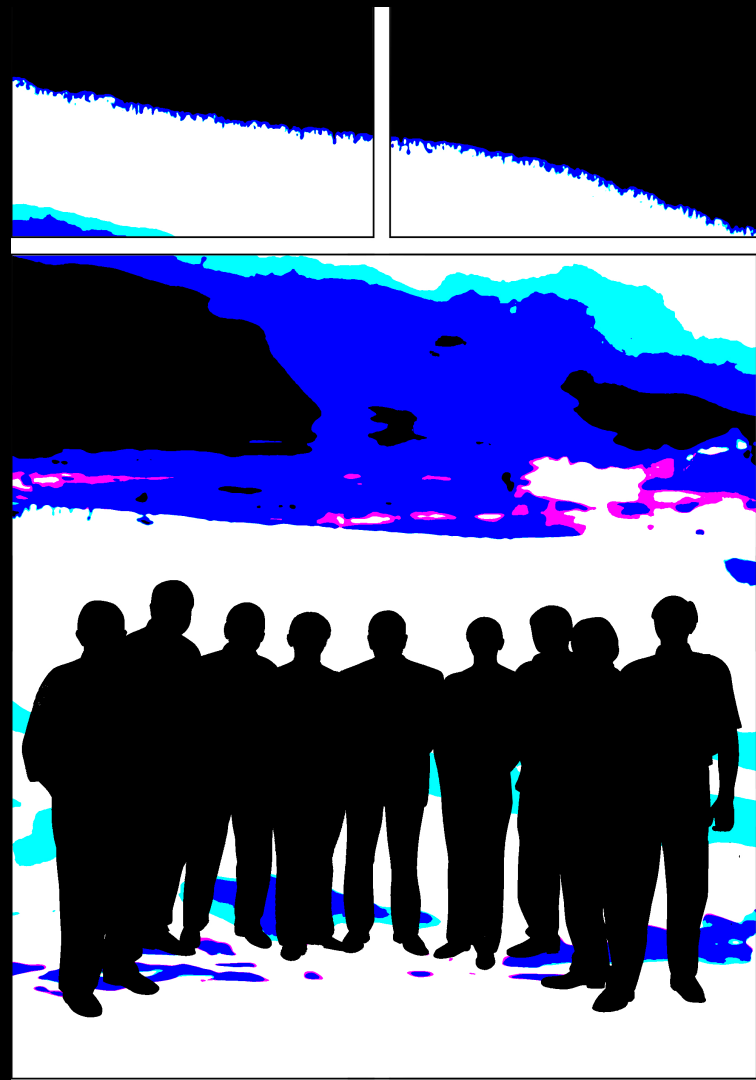
In the morning of the eclipse Mr Carneiro,

the Curador, Judge, Mr Wright and three Doctors came over. Just as they arrived a tremendous rain-storm came on, the heaviest we have seen. It was most unusual at that time of the year; but it was favourable for the eclipse as it helped to clear the sky. The rain stopped about noon. (The eclipse was at 2.15). There were a few gleams of sun in the afternoon, but it soon clouded over again. About 1.30 when the partial phase was well advanced, we began to get glimpses of the sun, at 1.55 we could see the crescent (through cloud) almost continuously, and there were large patches of clear sky appearing. We had to carry out our programme of photographs in faith. I did not see the eclipse, being too busy changing plates, except for one glance to make sure it had begun, and another half-way through to see how much cloud there was. We took 16 photographs (of which 4 are not yet developed). They are all good pictures of the sun, showing a very remarkable prominence, but the cloud has interfered very much with the star-images.



TCL: EDDN A412. LETTER TO MOTHER.  
JUNE 21 AND JULY 2, 1919. ITALICS MINE

On the morning of the eclipse Mr Carneiro [the owner of roça Sundy], the Curador [the man in charge of "imported labour"], Judge, Mr Wright [one of the two British black men who worked at the cable station], three Doctors came over. Just as they arrived a tremendous rain-storm came on, the heaviest we have seen. It was most unusual at that time of the year; but it was favourable for the eclipse as it helped to clear the sky. The rain stopped about no[o]n (the eclipse was at 2.15). There were a few gleams of sunshine after the rain, but it soon clouded over again.



About 1·30 when the partial phase was well advanced, we began to get glimpses of the sun, at 1·55 we could see the crescent (through cloud) almost continuously, and there were large patches of clear sky appearing. We had to carry out our programme of photographs in faith. I did not see the eclipse, being too busy changing plates, except for one glance to make sure it had begun, and another half-way through to see how much cloud there was.

We took 16 photographs (of which 4 are not yet developed). They are all good pictures of the sun, showing a very remarkable prominence; but the cloud has interfered very much with the star-images. The first 10 photographs show practically no stars. The last 6 show a few images which I hope will give us what we need; but it is very disappointing. Everything shows that our arrangements were quite satisfactory, and with a little clearer weather we should have got splendid results. Ten minutes after the eclipse the sky was beautifully clear, but it soon clouded again.

We developed the photographs 2 each night for 6 nights after the eclipse, and I spent the whole day measuring. The cloudy weather upset my plans and I had to treat the measures in a different way from what I had intended; consequently I have not been able to make any preliminary announcements of the result. But the one good plate that I measured gave a result agreeing with Einstein and I think I have got a little confirmation from a second plate.



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29. The days preceding the eclipse were very cloudy. On the morning of May 29 there was a very heavy thunderstorm from about 10 a.m. to 11.30 a.m.—a remarkable occurrence at that time of year. The sun then appeared for a few minutes, but the clouds gathered again. About half-an-hour before totality the crescent sun was glimpsed occasionally, and by 1.55 it could be seen continuously through drifting cloud. The calculated time of totality was from 2h. 13m. 5s. to 2h. 18m. 7s. G.M.T. Exposures were made according to the prepared programme, and 16 plates were obtained. Mr. COTTINGHAM gave the exposures and attended to the driving mechanism, and Prof. EDDINGTON changed the dark slides. It appears from the results that the cloud must have thinned considerably during the last third of totality, and some star images were shown on the later plates. The cloudier plates give very fine photographs of a remarkable prominence which was on the limb of the sun.

A few minutes after totality the sun was in a perfectly clear sky, but the clearance did not last long. It seems likely that the break-up of the clouds was due to the eclipse itself, as it was noticed that the sky usually cleared at sunset.

**SPACE TIME  
AND  
GRAVITATION**

**AN OUTLINE OF THE GENERAL  
RELATIVITY THEORY**

**BY**

**A. S. EDDINGTON, M.A., M.Sc., F.R.S.**

**PLUMIAN PROFESSOR OF ASTRONOMY AND EXPERIMENTAL  
PHILOSOPHY, CAMBRIDGE**

**WEIGHING LIGHT**

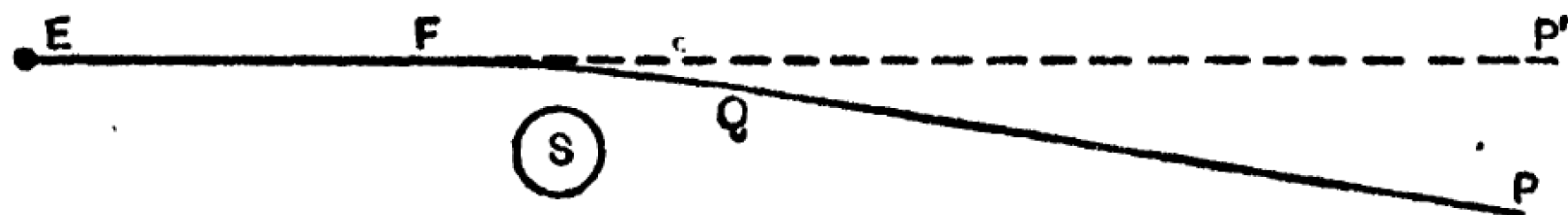


FIG. 16.

Our shadow-box takes up all our attention. There is a marvellous spectacle above, and, as the photographs afterwards revealed, a wonderful prominence-flame is poised a hundred thousand miles above the surface of the sun. We have no time to snatch a glance at it. We are conscious only of the weird half-light of the landscape and the hush of nature, broken by the calls of the observers, and beat of the metronome ticking out the 302 seconds of totality.

*The Eclipse Expedition to Sobral.*

The eclipse day opened very unpromisingly, the proportion of cloud at first contact being about 9/10. There were, however, useful glimpses of sunshine, which gave opportunities of placing the Sun's image at the assigned point on the plates, and of finally rating the driving clocks. The cloudiness during the early stages was doubtless the cause of the fall of temperature during totality being unexpectedly small; perhaps this latter fact was connected with the dead calm that prevailed during totality. From our experience of the locality we apprehended sudden gusts as the air cooled, and had arranged wind-screens, which fortunately were superfluous. A large clear space in the clouds reached the Sun's neighbourhood just in time, and for four out of the five minutes of totality the sky round the Sun was quite clear. For one minute about mid-totality there was thin cloud in this region; this, while hiding the stars, gave well-defined images of the inner corona and prominences, so that our photographic record of these is scarcely less complete than if we had specially endeavoured to secure them.

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and Mr. C. DAVIDSON.*

contact by observing the length of the disappearing crescent on the ground glass. When the crescent disappeared the word "go" was called and a metronome was started by Dr. LEOCADIO, who called out every tenth beat during totality, and the exposure times were recorded in terms of these beats. It beat 320 times in 310 seconds; allowance has been made for this rate in the recorded times. The programme arranged was carried

Crossing different kinds of sources, it becomes clear that both in roça Sundy, Príncipe and in Sobral, Brazil, expeditioners observed totality in the company of other participants, some of whom held prominent functions. Thus, despite their "invisibility", two types of local actors participated directly in the experiments, in Sobral as in Príncipe: the workers who provided the manpower to transport equipment, to build supports for the instruments or protective structures of the whole apparatus and also the members of the local elite who participated in the observations of totality or offered them the materials - clay pots or ice - necessary for the success of revelation of plates.

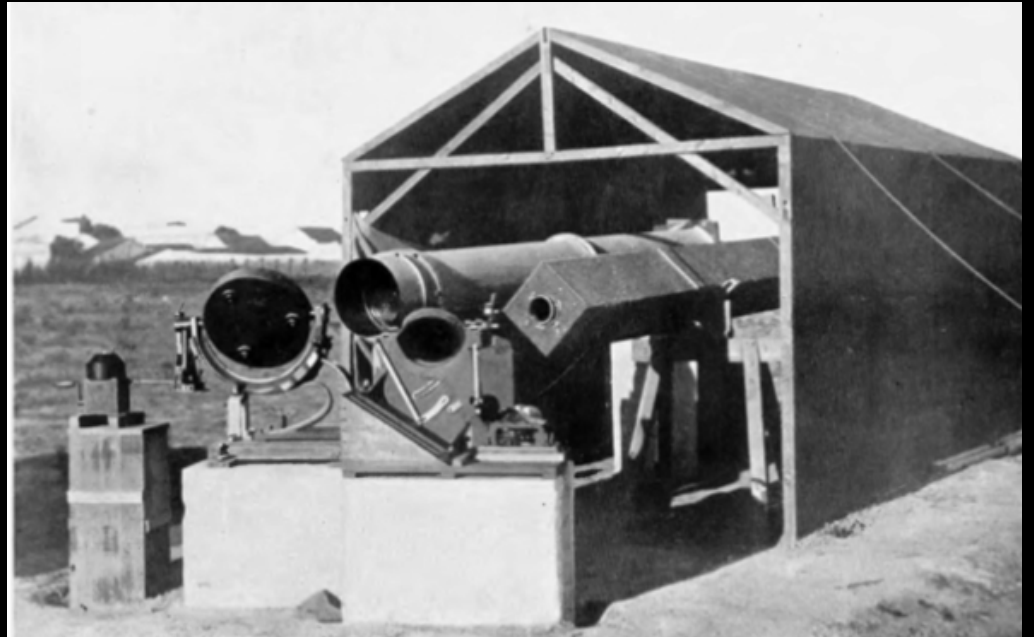


Finally, these local actors were joined by national astronomers and colonial authorities and individuals who, in both cases, ensured the success of the travels as well as their stop in Lisbon and Funchal, Madeira, where Eddington and Cottingham stayed for 26 days, and finally their stay and work in Sobral and in Príncipe.



TO DEPICT OR NOT TO DEPICT.  
WHEN VISUAL RECORDS MATTER









Brazilian team with British and American team members

Brazilian team with family and with British and American team members



Henrique Morize and wife

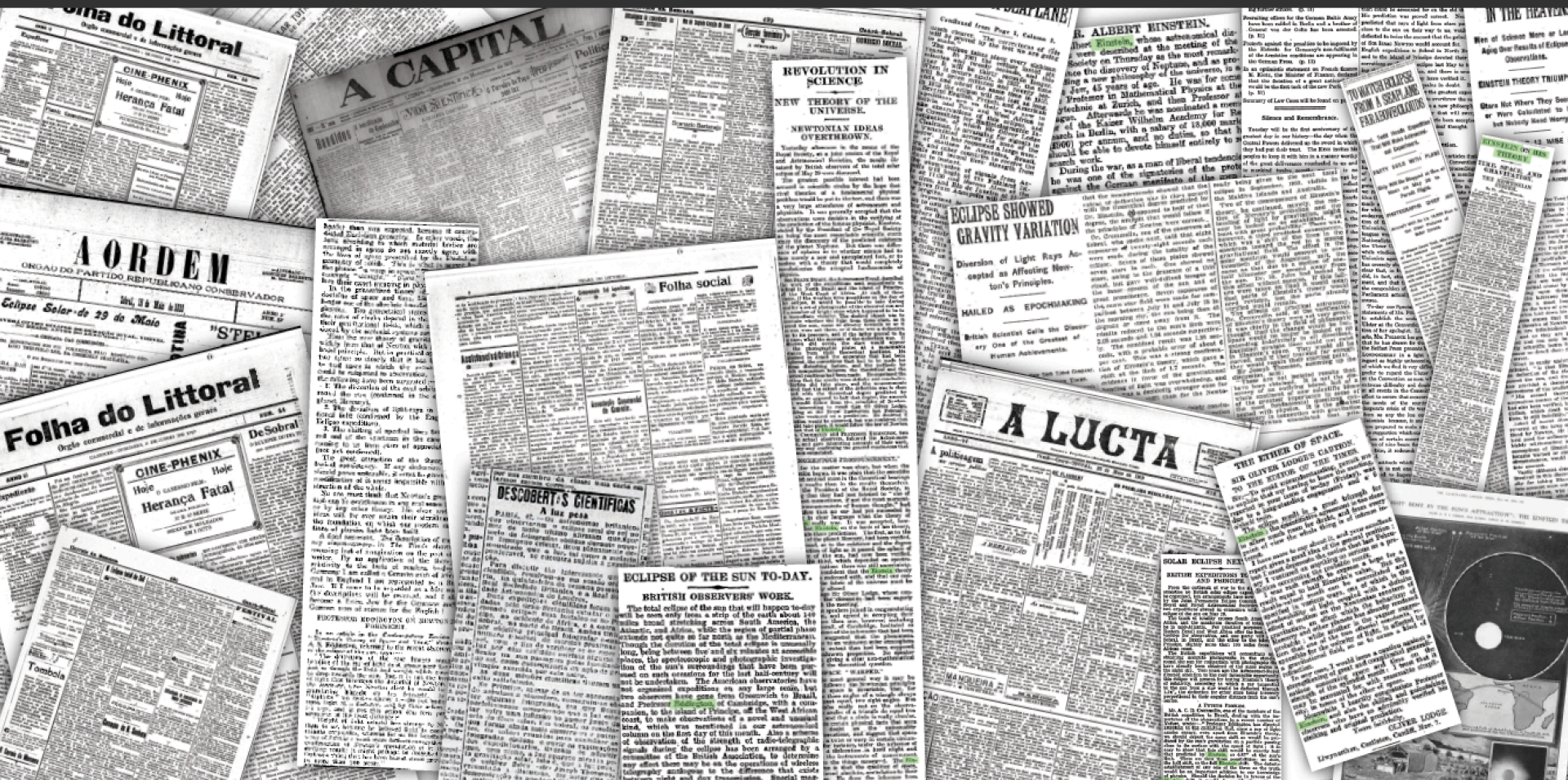


Members of Brazilian team





# Newspapers' coverage of the 1919 eclipse, with many news from Brazilian newspapers



BRAZIL' S PRESENCE.  
PORTUGAL' S ABSENCE

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Friday, 1917 March 9.

place on the west coast of Africa. We next come to “Prince’s Island,” better known as Principe, a well-developed Portuguese island which became celebrated a short time ago owing to the politicians’ interest in “slave cocoa.” The island is hilly. There is a good landing, and there are considerable factories for the cocoa plantations. At first sight it appears an agreeable place for an eclipse expedition. It has also a system of light trolley railways, which might be used for transporting baggage. There



#### IV. THE EXPEDITION TO PRINCIPE.

*(Observers, Prof. A. S. EDDINGTON and Mr. E. T. COTTINGHAM.)*

27. Principe is a small island belonging to Portugal, situated just north of the equator in the Gulf of Guinea, about 120 miles from the African coast. The extreme length and breadth are about 10 miles and 6 miles. Near the centre mountains rise

of these. Especial thanks are due to the Brazilian Government for the hospitality and facilities accorded to the observers in Sobral. They were made guests of the

Government, who provided them with transport, accommodation and labour. Dr. MORIZE, Director of the Rio Observatory, acting on behalf of the Brazilian Government, made most complete arrangements for the Expedition, and in this way contributed materially to its success.

On behalf of the Principe Expedition, special thanks are due to Sr. JERONYMO CARNEIRO, who most hospitably entertained the observers and provided for all their requirements, and to Sr. ATALAYA, whose help and friendship were of the greatest service to the observers in their isolated station.

OBSERVATORY  
CAMBRIDGE.

1918 Nov. 11

Dear Sir

The Royal Society and Royal Astronomical Society propose to send an expedition to the island of Principe to observe the total eclipse of May 29. The party will consist of Mr Botttingham and myself, and we shall devote ourselves to measuring the deflection of light (if any) by the sun's gravitational field with a view to testing Einstein's theory of gravitation. You doubtless know that the 1919 eclipse is exceptionally favourable for this purpose.

I venture to ask if you or your scientific colleagues in Lisbon could help us in regard to two matters. I suppose that for accommodation and facilities we should have to rely on the hospitality of one of the Portuguese companies occupying the island. Would it be possible for you to make inquiry of these companies and to put us in touch with the most suitable one so that we could make arrangements with them beforehand?

I also have to ask whether you could advise us as to the best means of travelling to Principe. I understand that before the war the Empresa Nacional de Navegação used to run boats to Principe which we could join either at Lisbon or Madeira. I should be glad of information as to whether this communication still exists. Alternatively, I learn



PT/MUL/OAL/C/240, Correspondence from Eddington to direction of OAL (mostly addressed to F.T. Oom), letter 11 November 1918.



Rec<sup>d</sup>  
1919 Jun 7

Rosa Sundy  
Principe  
May 4.

Dear Dr Gorn

We were very glad to receive your telegram in reply to my letter. We came out on the 'Portugal' arriving April 23.

We are being most kindly entertained by Mr Carneiro; and have everything we could possibly desire. Everyone has received us most kindly, and has given us every assistance. All we need now is a fine day for the eclipse.

This is a beautiful island, and besides making good progress with our work we are thoroughly enjoying our experiences.

With many thanks for your assistance and with kind regards,

Yours sincerely

PT/MUL/OAL/C/240, Correspondence letter Eddington to  
Oom, 3 August 1919

The Director

Observatorio Nacional

Sapada

Lisbon

Portugal.

from A.S. Eddington  
Observatory  
Cambridge

Recd 1919  
Ag 15  
c/3 for

OBSERVATORY,  
CAMBRIDGE

1919 Aug 3

Dear Sir

We arrived home on July 14  
after a pleasant voyage. I think  
you may be interested to have

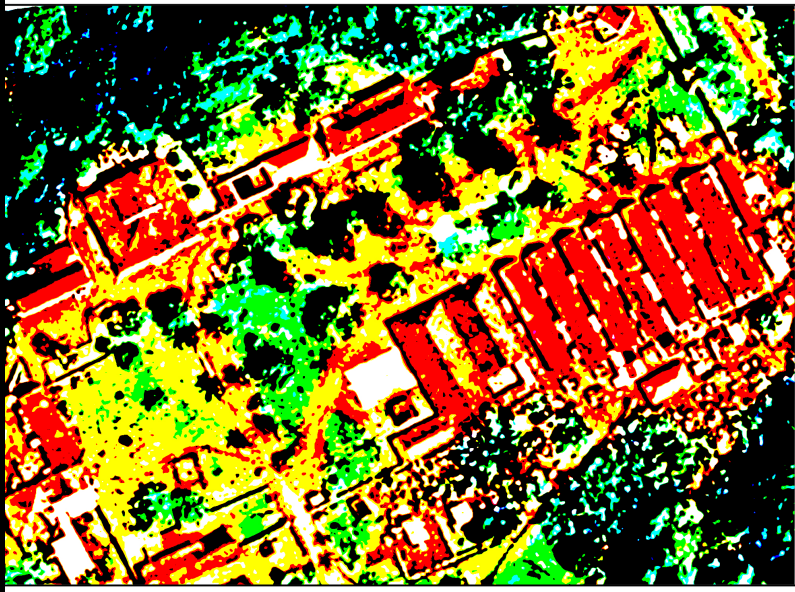
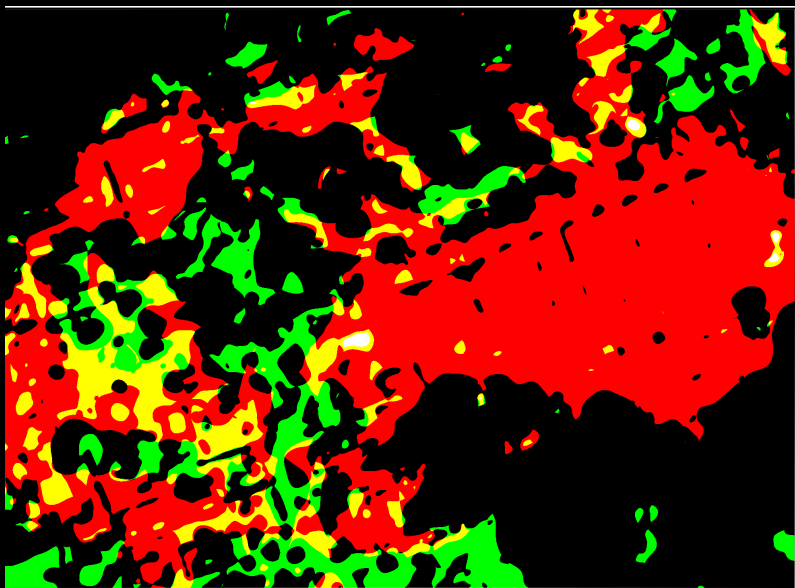
the enclosed paper enlargements  
from three of our negatives. They  
do not show all the fine detail of  
the original; but the prominence is  
very remarkable.

With many thanks to you &  
Dr. Com for your great kindness &  
help to us. Yours sincerely  
A.S. Eddington











CONCLUDING  
REMARKS

Anónimos no Príncipe

Manuel Peres

Erwin Finlay Freundlich

Mecânicos no Sobral

Charles Rundle Davidson

Wilhelm de Sitter

Wright, trabalhador da estação de cabo

Equipa do Observatório Nacional do Rio de Janeiro

Ernesto de Vasconcelos

Newall Herbert Hall Turner

Membros da elite do Sobral

Aloysius Laurence Cortie

Frederico Thomaz Oom

Arthur Hinks

Alfred Fowler

Carpinteiros no Príncipe

Heber Doust Curtis

J.J. Thomson

Henrique Carlos Morize

Curador do Príncipe

Passageiros do Polycarp

Lindeman

Andrew C.C. Crommelin

Albert Einstein

H. Lorentz

Leocádio Araújo

Jutz do Príncipe

Mecânicos em Greenwich

Frederick Brown

Arthur Stanley Eddington

Ramos da Costa

Carpinteiros no Sobral

Coronel Vicente Saboya

M.S. Melo e Simas

Andrew Thomson

Frank Watson Dyson

Daniel Wise

Jornalistas

Alfred North Whitehead

Passageiros do Portugal

Passageiros do Zaire

Jerónimo José Carneiro

Silberstein

Mecânicos no Príncipe

Passageiros do Anselm

C.A. Campos Rodrigues

Charles Dillon Perrine

Anónimos no Sobral

Carpinteiros em Greenwich

Edwin Turner Cottingham

William Wallace Campbell

Membros da elite do Príncipe

# TOWARDS A GLOBAL HISTORY OF THE ECLIPSE OF 29 MAY 1919

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**CIUHCT**

Centro Interuniversitário de História  
das Ciências e da Tecnologia  
FCUL | FCT - UNL

BSHM GRESHAM LECTURE  
LONDON, 23 OCTOBER 2019