



A Report on the Anniversary Celebrations of Eddington's Eclipse Expedition to Principe.

In the spring of 1919, British astronomer Arthur Eddington travelled to the small island of Principe, in the Gulf of Guinea, to carry out what would become one of the landmark experiments of contemporary physics. His measurements would not only confirm Albert Einstein's Theory of General Relativity, they would kick start our modern understanding of the Universe and how it evolved. The phenomenon of gravitational lensing that the test used now gives us a unique window on the Cosmos. It is fitting that, 90 years later in the International Year of Astronomy, a group of us have gone back to commemorate this event with the people of São Tomé and Príncipe.

Eddington's Expedition.

Einstein's Theory of General Relativity predicts that light will be deflected as it propagates through the warped space-time around a massive object: a phenomenon known as gravitational lensing. The amount of deflection can be calculated accurately and differs from a similar effect in Newtonian gravity by a factor of two. Hence a measurement of this deflection is a sure way of discriminating between these two theories of gravity.

In 1919, a total eclipse of the Sun supplied an excellent opportunity to measure the difference in deflection angles. During the eclipse, the Sun would lie in front of the Hyades star cluster, the richest concentration of stars on the ecliptic plane. Arthur Eddington, the Plumian Professor of Astronomy and Director of the Cambridge Observatory, took photographs of the stars from Oxford in January. He would then photograph it again during the eclipse in May. By comparing the ordinary positions of the stars with the apparent positions during the eclipse, he would be able to measure the deflection of light due to the Sun.

Eddington, and his collaborator Cottingham, travelled to the island of Príncipe, from where the eclipse would be visible, while his colleagues Crommelin and Davidson set out to perform the same experiment in the small city of Sobral, in

the North-East of Brazil. São Tomé and Príncipe was an isolated outpost of the Portuguese empire, which until recently, had been the main worldwide supplier of cocoa. The smaller island of Príncipe was sparsely populated and covered by large plantations. Eddington picked the Sundry plantation to set up the experiment.

The total eclipse, on the 29th of May, 1919, was almost obscured by clouds. Fortunately, for a brief window of time, the sky was sufficiently un-obscured for Eddington and Cottingham to make their observations at same time as Crommelin and Davidson in Sobral. The two experiments, combined with the measurements from Oxford made a compelling case for gravitational lensing from General Relativity.

The Legacy of the 1919 expedition.

The 1919 expeditions to Príncipe and Sobral kick-started a revolution in theoretical physics and astronomy, and made Einstein an international celebrity. From Einstein's theory it became possible to construct a mathematically consistent model of the Universe: a Universe that expands and cools with time. Yet another set of predictions that arise from an expanding Universe have been confirmed with stunning accuracy: we measure galaxies receding out to cosmological distances, there is a relic bath of light left over from the hot thermal beginning of the cosmos and the abundances of light elements is consistent with a phase of nucleosynthesis when the Universe was only a few minutes old.

The phenomenon of gravitational lensing, the crucial test of the 1919 expedition, has developed to become one of the workhorses of modern astronomy and astrophysics. A gravitational lens can be used as a telescope larger than any on Earth, to see more distant objects than otherwise possible. It has also been used to measure the abundance of dark compact objects, candidates for the elusive dark matter, to measure the density profiles of clusters of galaxies, to detect black holes and constrain the growth of structure in the Universe. It is now at the heart of many up and coming observatories, either from ground or from space, to constrain the nature of dark energy. Without a doubt, gravitational lensing has given us a new perspective on the Cosmos.

The celebrations.

The idea of celebrating 1919 expedition to Príncipe was first discussed by one of us, Gisa Weszkalnys, in the autumn of 2007, with the President of the Region of Príncipe. Together with Richard Ellis, a plan was put forward to place a plaque at Sundry with a brief description and explanation of the experiment. The plaque would be unveiled during a set of events that would include public lectures and a small exhibition. This proposal was put forward to the Royal Astronomical Society and the International Astronomical Union with a request for funding. Gisa Weszkalnys and Richard Ellis visited São Tomé and Príncipe in September of 2008 where they secured the full support of the São Tomean government and were graciously received by the President of the country, Fradique de Menezes.

In parallel, the Lisbon Geographical Society, planned to commemorate the event by organizing a small workshop in Lisbon followed by a series of events in São Tomé and Príncipe. Funded by the Portuguese Ministry of Science and Technology, and with the support of the RAS and the IAU, a combined event was planned. Richard Massey designed a bilingual plaque, which was constructed in Edinburgh then shipped to São Tomé.

The official celebrations began on the 22nd of May in Lisbon with Pedro G. Ferreira giving a talk on the legacy of Eddington's measurements. That evening, we (Gisa Weszkalnys, Richard Massey and Pedro Ferreira) along with representatives from the Lisbon Geographical Society, flew to São Tomé for a week of celebrations. Throughout our stay we were put up in the Omali Lodge (in São Tomé) and the Bom Bom Resort (in Príncipe) thanks to the generosity of Dutch eco-entrepreneur Rombout Swanborn.

During the week we gave a series of popular talks on Eddington and astronomy in lecture theatres at the Portuguese Cultural Centre and the Polytechnical Institute (which stands as the main higher education institute in São Tomé). These were supplemented with receptions at various embassies and interviews with the local radio, newspapers and the BBC World Service. During the week of the trip, Eddington and Einstein were very much in the media in São Tomé. While we were in São Tomé, three members of the NGO, Scientists in the World, flew over to Príncipe and throughout the week ran workshops with the teachers and children in the schools on the island.

On the morning of the 28th of May, we were flown over to Príncipe on a small Dornier airplane to be hosted by President José Cassandra and various members of the Príncipe government. We gave two talks in the National Assembly and were then driven to Sundry plantation where the local villagers celebrated our arrival. In the middle of drumming, singing and dancing we brought out some telescopes and observed the clear night sky with enthusiastic children who had turned out for the event. That evening we ate traditional dishes in the sumptuous dining hall of the main house in a dinner hosted by the president.

The formal celebration took place in the forecourt of the Sundry Plantation, with the unveiling of the plaque by President José Cassandra. The local villagers turned out en masse and a number of flights had been chartered to fly over a selection of diplomats, government ministers, civil servants, academics and journalists. A new set of postage stamps was commissioned for the purpose, celebrating Eddington in Príncipe. The unveiling was followed by a series of speeches by, amongst others, the president, the Minister of Education, and Pedro G. Ferreira representing the RAS and IAU. The formal events were followed by a lunch with open-air entertainment, dancing and a session of *dêxa*, a traditional form of music from the region. That afternoon, we flew back to São Tomé and the following morning we returned to Europe.

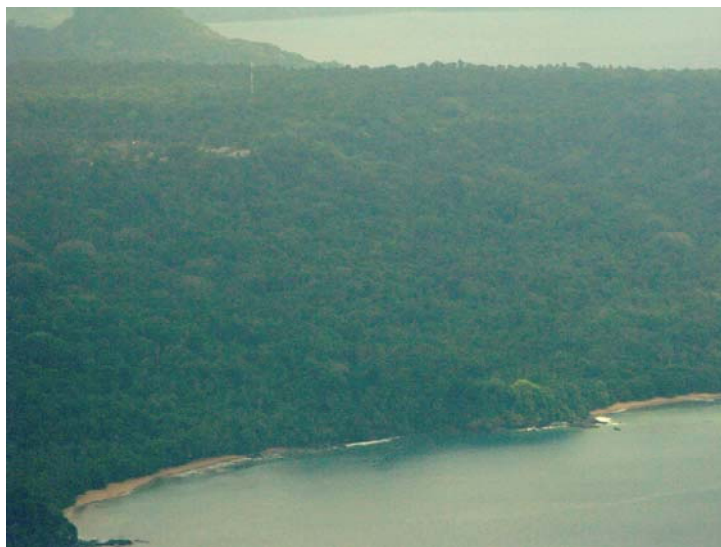
The Future.

Our visit was met with tremendous enthusiasm and interest. Throughout our stay, our hosts repeatedly suggested that such events should happen more often: either through annual lectures and workshops for teachers and students on the

island or with the development of a centre celebrating the event in Príncipe. An international scientific conference “New Worlds in Astroparticle Physics” will be held on São Tomé in September. The regional and national government are keen on pursuing such ideas and some of the embassies have shown interest in financially supporting the endeavour. It is clear that Eddington’s trip to Príncipe can be an important part of São Tomean cultural heritage and we hope there will be support for these initiatives in the future.



President José Cassandra unveils the plaque describing Eddington's experiment, at Roça Sundry plantation, on 29th May 2009. Underneath is a detail from the plaque.



Roça Sundry (left of photo) is a remote plantation, surrounded by tropical rainforest on a distant island. The Príncipean government is keen for the historic science conducted here to become an integral part of local culture and a viable attraction for ecotourists, bringing valuable income.



The anniversary celebrations at Roça Sundy were warmly taken up by the local residents, who arranged a show of dancing, music and *dêxa*, a traditional form of song from the region.



A new set of postage stamps issued on São Tomé and Príncipe to celebrate the anniversary of Eddington's 1919 expedition.



Prof. Pedro Ferreira talks to a crowded room in the capital city of São Tomé. A series of public outreach talks in Europe and Africa has been well attended, and received mainstream media attention during the week of the anniversary itself.