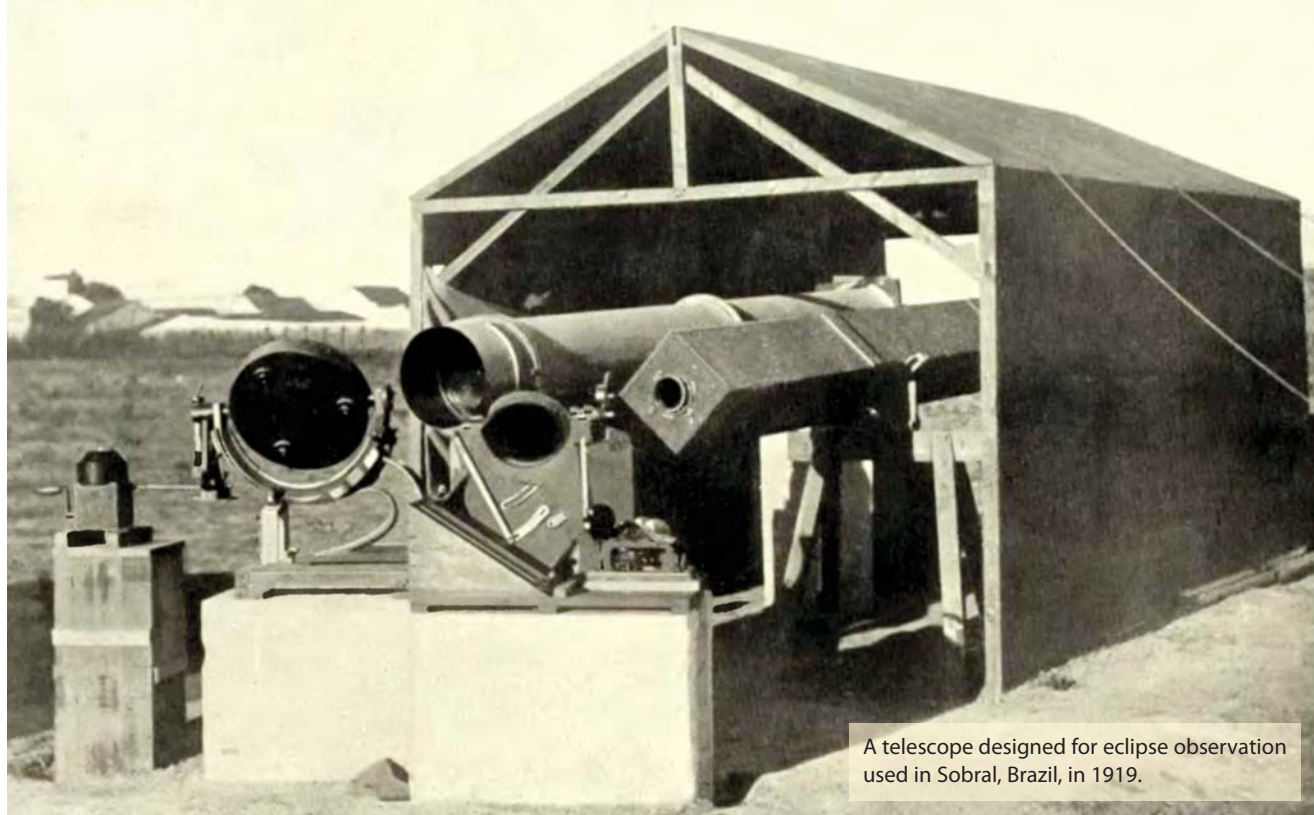




A telescope designed for eclipse observation used in Sobral, Brazil, in 1919.

C. DAVIDSON, PD-US

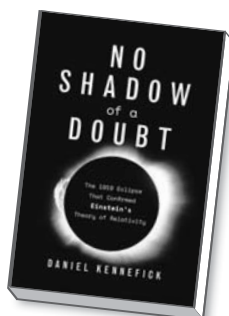
# The significance of the 1919 total solar eclipse

If you are interested in the first successful test of Einstein's prediction about light bending, you should find Daniel Kennefick's *No Shadow of a Doubt: The 1919 Eclipse That Confirmed Einstein's Theory of Relativity* very informative, despite its flaws. Kennefick delves into details of the 1919 solar eclipse expeditions, the people involved, the data analyses that followed, and much more.

One of Kennefick's main goals and achievements is to rescue from current obscurity many who played an important role in that century-old work. Who, for example, remembers Frank Watson Dyson, then the Astronomer Royal of Great Britain and director of the world-renowned Royal Greenwich Observatory? He was the first to realize the opportunities presented by the 1919 eclipse and was instrumental in obtaining funding for the expeditions. He also successfully persuaded the authorities to delay until after the eclipse the military conscription of the eclipse's best-known figure, astronomer and Quaker pacifist Arthur Stanley Eddington. Although he did not go there himself, Dyson was in charge of the eclipse expedition to Sobral, Brazil; Eddington led the one to

**No Shadow of a Doubt**  
The 1919 Eclipse That Confirmed Einstein's Theory of Relativity

Daniel Kennefick  
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Principe Island off the west coast of Africa.

Even less likely to be remembered is Charles Rundle Davidson, who worked for Dyson. Davidson went to Sobral, and despite his lack of university education became the final arbiter on all issues involving the use of eclipse observation equipment there. He was later intimately involved with the data analysis. Similarly, important contributors in Ireland—Howard Grubb, for example—have largely been forgotten. Grubb had much earlier made key optical equipment that was used to replace vital items stranded in the Russian Pulkova Observatory by the military hostilities of World War I.

As Kennefick makes clear, the results from the eclipse expeditions received

worldwide publicity largely because of Eddington's involvement. That publicity made Albert Einstein a world-renowned figure. Kennefick also notes that Eddington hoped to help repair the damage World War I had inflicted on international cooperation among scientists. What better way to encourage reconciliation than for British scientists to verify a theory proposed by a German to replace that of the most famous British scientist of all, Isaac Newton?

A substantial part of *No Shadow of a Doubt* is devoted to a detailed discussion of the eclipse data analysis, including the seemingly arbitrary deletion of some of the data. One surprise is that the Principe plates were not retained and so could not be reanalyzed as the Sobral data were in the late 1970s. That reanalysis yielded nearly the same results as in 1919.

In my view, Kennefick overstates the significance of the 1919 findings, starting with the book's title. For example, Dyson was looking forward to later eclipses and opined that he wouldn't be surprised if future results did not support Einstein's prediction. That is hardly a statement an intimately involved scientist would make if he thought the 1919 conclusion had "no shadow of a doubt."

Kennefick also says that the 1919 eclipse "may well have been the most important scientific experiment of the entire twentieth century." Despite the "may," that sentence seems to me to be a stretch. Even if we agree to consider only tests of

the general theory of relativity, a strong case could be made that the 1922 eclipse measurements were at least as important. A Lick Observatory team made those measurements, which yielded a light deflection at the solar limb of  $1.72 \text{ arcsec} \pm 0.11 \text{ arcsec}$  probable error, in close agreement with Einstein's prediction of  $1.75 \text{ arcsec}$ . By contrast, the result from the 1919 eclipse was  $1.98 \text{ arcsec} \pm 0.12 \text{ arcsec}$  probable error for Sobral and  $1.61 \text{ arcsec} \pm 0.3 \text{ arcsec}$  probable error for Principe.

In soaring and elegant prose, Ken-

nefick claims that Eddington and Dyson "deposed Newton's theory of gravity from its perch as the greatest achievement of the human intellect." In my view, not only is that placement of Newton's theory arguable, but the theory could well be considered to have been deposed before 1919. For the previous 60 years a glaring inconsistency of  $43 \text{ arcsec per century}$  had existed between observations of the advance of the perihelion of Mercury's orbit and the smaller prediction of Newton's theory. By contrast, Einstein showed some years

before 1919 that his theory explained that inconsistency to within the uncertainty of its measurement. That result thus deserves much if not most of the deposing credit.

In addition to some problematic discussions of philosophical issues such as the distinction between science and non-science, the book also contained a large number of errors. I mention only a few explicitly: Kennefick's description of the transverse Doppler shift and his definition of a parsec were off, his definition of a pulsar was wanting, and his labeling of the European Space Agency's Hipparcos mission as NASA's was embarrassing.

As a point of personal privilege, I note that Kennefick also errs when he describes how C. W. Francis Everitt used Gravity Probe B to test another prediction of general relativity, frame-dragging. Kennefick says that Everitt had "arranged for the analysis of the Gravity Probe B data to be done in the blind, with a key ancillary part of the experiment conducted by a separate group [mine] who were to keep their results secret until after Everitt's team presented their own measurements." However, the idea for blinded data analysis, described somewhat inaccurately by Kennefick, was mine. For various reasons, Everitt—for whom I have the utmost respect—did not follow that plan, contrary to a fair reading of Kennefick's whole statement.

Finally, I wondered throughout my reading of the book who Kennefick intended as his main audience. I didn't find a satisfactory answer. If the generally educated and curious layperson was the intended audience, then why did he write sentences such as "the theory of black holes led to fascinating concepts like black hole thermodynamics, Hawking radiation, and the Penrose process," without any explanation of those concepts? If the intended audience was professional physicists, then why did he discuss the basics of Euclidean geometry and elementary aspects of error analysis?

Kennefick's book is clearly based on extensive research and includes far more interesting material than I could possibly mention here. Perhaps the forewarned reader can successfully filter its disconcerting problems and take advantage of the apparently good information.

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