The New York Times

Opinion

How Einstein Became the First Science Superstar

A century ago, astronomers proved the general theory of relativity — and

Albert Einstein, around 1919.

By Ron Cowen
Mr. Cowen is the author of "Gravity's Century: From Einstein's Eclipse to Images of Black Holes."

Nov. 6, 2019

Early in 1919, two teams of British astronomers embarked on a journey to the far reaches of the planet to observe a solar eclipse. Nearly eight months later, on Nov. 6, 1919, the teams presented their findings before a packed audience of scientists in London. Their announcement changed forever how humans view the universe.

The teams' report, coming less than a year after the end of World War I, was noteworthy for another reason: It may have helped heal the wounds of war. The British eclipse expedition was designed to test a new theory of gravity proposed by Albert Einstein, a German-born scientist who had published his work behind enemy lines. If the British proved him right, his theory would topple that of Isaac Newton, a founding father of modern scientific thought and a national hero in Britain.

Newton had viewed gravity as a force that acts across space, pulling massive bodies together. Einstein replaced that notion with the radical proposition that gravity *is* space. Rather than stiff and immutable as the floorboards of a stage, space and time, he said, jiggles like jelly. A massive body dents this jiggly space-time much the way a lead weight sags a sheet of rubber. Earth is attracted to the sun not because of a force but because the sun has dimpled the space-time through which our planet must travel.

As early as 1911, Einstein had suggested a way to verify his outlandish proposal, known as the general theory of relativity. If a body is massive enough — like the sun — scientists should be able to observe the curved or bent path of all objects traveling in its vicinity, even particles of starlight. Through a telescope, the bending of starlight would show up as a change in the apparent position of the star compared with its position when the sun was in another part of the sky.

Under ordinary conditions, attempting such an observation would be folly. The blinding light of the solar disk would completely swamp the much fainter light from surrounding stars. But the stars pop into view during those rare times and places when the clockwork motion of the solar system places the moon directly between the sun and Earth.

Beginning in 1912, several attempts to search for Einstein's gravitational light-bending during a solar eclipse had failed, mainly because of bad weather. But the Great War also played a role. The German astronomer Erwin Finlay Freundlich had just arrived in the Crimea to study the solar eclipse of Aug. 21, 1914, when the war broke out. He and his associates were promptly interned in Russia as spies and their equipment was confiscated.

Einstein himself hated the war. In October 1914, 93 German scientists signed a proclamation giving their unqualified support to the German military. Einstein refused to sign the "Manifesto of the Ninety-Three" and instead was one of just four scientists to endorse a proclamation protesting Germany's aggression.

Although Einstein blocked out the war as best he could, sometimes it was too close to be ignored. His office was in the Kaiser Wilhelm Institute for Physical Chemistry in Berlin. To aid in the war effort, the institute's director, Fritz Haber, and his collaborators had begun experiments with chlorine, a poisonous gas. On Dec. 17, 1914, a test tube of cacodyl chloride, an unstable substance, caught fire in Haber's laboratory. The subsequent explosion blew off the right hand of one researcher and killed another. Fortunately for Einstein, he was unharmed.

By 1916, Einstein had a new and unexpected champion of his work — the British astronomer Arthur Eddington, a lifelong Quaker who was nearly jailed for his refusal to serve in the British Army. Eddington became enamored of Einstein's work after reading several of his seminal papers, smuggled into

Britain through the Netherlands, which had stayed neutral. He exhorted his colleagues at scientific conferences to embrace the theory, published review articles on Einstein's mysterious concept of curved space-time, and defended the work when critics tried to disparage it.

Arthur Eddington, left, with the Dutch astronomer Jacobus Kapteyn at the Congress of Astronomers in Potsdam in 1921, the first after World War I. Bettmann Archive/Getty Images

Keen to test Einstein's light-bending prediction, Eddington and Britain's astronomer royal, Frank Dyson, began looking ahead to an eclipse that would occur on May 29, 1919.

The 1919 event appeared promising on several counts, Dyson pointed out to readers of The Observatory, the Royal Astronomical Society's monthly newsletter. The eclipse would last more than six minutes, one of the longest in the 20th century. What's more, the occluded sun would pass through a rich background of stars, the Hyades cluster, providing a bounty of celestial light with which to test Einstein's prediction. Another plus: These stars were relatively bright, and therefore would be easier to see.

While Dyson and Eddington contemplated plans to observe the 1919 event, the war continued to ravage Europe. By early 1918, the British military was desperate to replace the hundreds of thousands who had died. The cases of men who had been granted a military exemption came under harsher scrutiny. In January 1918, a military tribunal argued that Eddington, single and 35 years old, should have his occupation-based exemption terminated in three months. In April, he was granted a three-month extension, but at a hearing on June 14, 1918, in Cambridge, the military succeeded in revoking Eddington's exempt status.

Ultimately, a letter from Dyson, who had become chairman of the Joint Permanent Eclipse Committee of the Royal Astronomical Societies, convinced the authorities that it was in the best interest of British science to study the 1919 eclipse — and that Eddington should lead the expedition.

And so on March 8, 1919, with Europe still technically at war (the Versailles peace treaty was not signed until June), the two teams set sail from Liverpool on the steamship Anselm.

The teams traveled thousands of miles to the Amazon and Africa to observe the brief dimming of the sun. Eddington and a clockmaker from Northamptonshire, Edwin Cottingham, went to Principe, a Portuguese-owned island off the west coast of Africa, while Andrew Crommelin and Charles Davidson of the Royal Greenwich Observatory traveled to Sobral, in northern Brazil.

As the moon inserted itself between the sun and Earth for six minutes and 51 seconds on May 29, 1919, Eddington and his colleagues photographed the stars that came into view as brilliant day turned to sudden night.

Conditions at Principe were not ideal. A rainstorm ended two hours before the eclipse reached its totality, but left behind intermittent clouds. In Sobral, astronomers were dismayed to find that photographic plates from one of the imaging instruments were out of focus. The sun's heat had apparently caused a mirror to expand unequally. It would be difficult if not impossible to use those images to determine whether Einstein or Newton was right.

When the observers went home, they compared the images they had taken with those of the same stars when they were not near the sun to find out how much, if any, that starlight had been bent.

On Nov. 6, after months of work, the two teams were finally ready to share their results before a joint meeting of the Royal Society and the Royal Astronomical Society. Most of the astronomers who had gathered in the Great Hall of the colonnaded Burlington House, in London, did not know what was to be announced. J. J. Thomson, president of the Royal Society and a Nobel laureate in physics for his discovery of the electron, presided over the meeting.

"The whole atmosphere of tense interest was exactly like that of the Greek drama," wrote the mathematician and philosopher Alfred Whitehead, who was present in the packed room. "There was a dramatic quality in the very staging — the traditional ceremonial, and in the background the picture of Isaac Newton to remind us that the greatest of scientific generalizations was now, after more than two centuries, to receive its first modification. Nor was the personal interest wanting: a great adventure in thought had at length come safe to shore."

The measurements had large uncertainties, and some scientists in the audience were skeptical. But Thomson spoke for those in the assembly who believed that Einstein was right: "This is the most important result obtained in connection with the theory of gravitation since Newton's day and it is fitting that it should be announced at a meeting of the Society so closely connected with him."

The next morning, Nov. 7, only a few days before the first anniversary of the armistice, the front page of The Times of London was full of stories about war and remembrance. King George V had just issued an invitation for all workers to take two minutes of silence out of their day to remember and honor "the glorious dead." But to the right of these articles appeared one about rebirth and renaissance. In a triple-decker headline, the normally staid Times wrote: "Revolution in Science/ New Theory of the Universe/ Newtonian Ideas Overthrown."

The news set off a chain reaction around the globe. The New York Times followed suit with a story on Nov. 10: "Lights All Askew in the Heavens … Einstein Theory Triumphs."

In Berlin, Einstein awoke as usual in the apartment he shared with his second wife and two stepdaughters. The city was still consumed with the privations of war and its aftermath, including scarcities of food and fuel for heat, and he very likely spent his morning focused on his family's immediate needs. But that morning, he became the first science superstar. Einstein wrote to a colleague that he felt sure his sudden fame would soon die down. He was wrong. His celebrity would endure not just for days or weeks but throughout his lifetime, and beyond.

When Einstein formulated his general theory of relativity, the universe seemingly consisted of a single galaxy; today, we know not only that the universe has at least 100 billion galaxies, but that it is expanding, ballooning at a faster rate every second. Over the past few decades, astronomers have found that there's much more to the universe than can be seen through the eye of a telescope; invisible entities called dark matter and dark energy are now known to make up about 96 percent of the cosmos. Giant black holes — light-guzzling gravitational maws in space-time — may lie at the center of every large galaxy, and ripples in space-time, known as gravitational waves, rumble through the cosmos.

Anyone trying to make sense of these discoveries owes a debt to the general theory of relativity. A century later, Einstein's masterpiece continues to open new and unexpected windows on the birth and life of the cosmos.

Ron Cowen is the author of "Gravity's Century: From Einstein's Eclipse to Images of Black Holes."