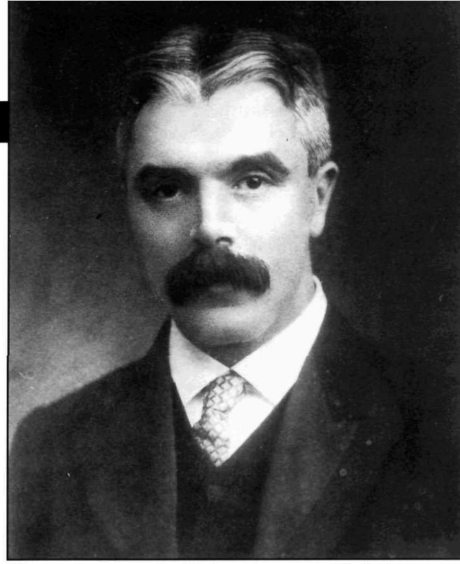
Bruce Medalist Profiles



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Frank W. Dyson: The Seventeenth Bruce Medalist

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Frank Watson Dyson
8 January 1868 - 25 May 1939
1922 Bruce Medalist

Those whose picture of nineteenth century Britain was formed by reading Charles Dickens may think that a poor lad's only hope was to discover that he was the long-lost heir to a rich nobleman. This picture is false; there were many roads to success for poor boys in Victorian England, and early evidence of mathematical ability was one. Indeed, all seven Bruce medalists[1] born in England during the reign of Queen Victoria (1837-1901) started in poverty but won scholarships which led directly to highly successful careers in astronomy.

One of these was Frank Dyson.

The oldest of seven children of a Baptist minister, Dyson came in first in a national mathematics contest at age thirteen. The resulting scholarship led to a well-equipped and well-staffed preparatory school and then to more scholarships to Cambridge University, where he studied mathematics and astronomy. A daughter recalled that he "loved mathematics for its own sake and was always happy puzzling over its problems." After graduating with honors, he continued at Cambridge as a fellow, winning some renown for calculating the gravitational potential of an anchor ring. Engaged to marry, he eagerly accepted an offer to become Chief Assistant at the Royal Observatory, Greenwich in 1894.

Dyson's first assignment was to supervise the compilation of the Greenwich portion of the *Carte du Ciel* or Astrographic Catalogue, a worldwide project established in Paris in 1887. Directors of eighteen observatories had divided up the sky and each agreed to make a photographic atlas and chart of a zone. This meant photographing a great many small fields with exposures of forty minutes for the chart, which was to show all stars as bright as 14th magnitude, and for six minutes, three minutes, and twenty seconds for the atlas. Each star's position and magnitude had to be measured and numerous calculations made for the reduction, the elimination of unwanted effects of plates, instruments, and motions of the earth. Although he knew nothing of instruments and observation when appointed, Dyson learned quickly and was always willing to lend a hand to the observers. With his genial and modest ways he soon won the loyalty of the assistants and computers.

Many plates had already been made by his predecessor, Herbert Hall Turner. Dyson came up with an improved way to reduce the measurements. He instituted new determinations of the locations of the reference stars from which other stars' positions were measured. He re-reduced visual measurements made by English amateur Stephen Groombridge some eighty years earlier, greatly increasing the precision of the stars' positions, and then he and W.G. Thackeray found the *proper motions* (motions across the sky, measured in arcseconds per year) of 4239 stars near the north celestial pole. Analysis of these motions led to improved values for the rate of the Earth's precession and for the direction

1. Ernest W. Brown, Frank W. Dyson, Arthur S. Eddington, Herbert H. Turner, Alfred Fowler, E. Arthur Milne, and Harold Spencer Jones. (William Huggins was born before Victoria's reign, and David Gill was born in Scotland.)

in which the solar system is moving with respect to the stars. Dyson and Thackeray found that the motions of the stars were related to their magnitudes and their distances from the Milky Way. They provided important data for Karl Schwarzschild, Arthur S. Eddington, and Jacobus C. Kapteyn, who were constructing models of stellar motions in what later became known as our Galaxy. They found that the fastest-moving stars moved in two streams, confirming a discovery of Kapteyn's.

Life was good for Dyson and his bride. They rented a ten-room house, which they immediately began to fill with children, on a hill near the Observatory and its deer-filled park. Dyson became captain of the Observatory's field hockey team, and he and his wife regularly gathered with friends to read Shakespeare. He became an active member of the Royal Astronomical Society, attending essentially all of its monthly meetings and beginning service on its Council that would last for thirty-seven years. He started writing popular articles and giving public lectures on astronomical topics.

Dyson assisted Christie on an eclipse expedition to Portugal in 1900, and the following year he was sent on his own to observe an eclipse in Sumatra. An amateur astronomer friend went along to help, and they had considerable assistance from the crew of a British naval vessel. After sailing through the Suez Canal and across the Indian Ocean, they built concrete piers for the instruments, practiced repeatedly so as not to lose any time during the precious minutes of totality, and made their photographs under clear skies. (After viewing six eclipses, with good weather every time, Dyson called himself "a hundred percent eclipse observer.")

In Sumatra Dyson obtained spectra of the solar chromosphere and corona, including the first detection of the element europium in the Sun. In 1905 he published wavelengths and intensities of 1200 emission lines he had photographed in the spectrum of the chromosphere on three expeditions. He confirmed a suggestion of J. Norman Lockyer[2] that there are real physical differences between the chromosphere and the photosphere.

With his reputation growing as an excellent practitioner of both the old mathematical astronomy and the new astrophysics, it is not surprising that Dyson was appointed Astronomer Royal for Scotland when that position became vacant in 1905. The position included an almost-new observatory with 15- and 24-inch telescopes, a house large enough for his growing family, and a professorship at the University of Edinburgh.

Dyson accomplished much during his five years in Scotland. Having been the first to complete his observatory's portion of the *Carte du Ciel* at Greenwich, he now agreed to measure and reduce plates made by the astronomer at Perth, Australia, who had gotten far behind schedule in dealing with his zones. Dyson also began a study of double stars too close to the north celestial pole to be reached by the Greenwich refractor, a project that continued long after he left Edinburgh. He secured better instrumentation for Jacob Halm's spectroscopic measurement of the period of rotation of the Sun. He became a popular professor at the University of Edinburgh, often inviting students to his home. His lectures on introductory astronomy became his first book.

In 1910 Dyson hosted a group of physicists who attempted (unsuccessfully) to measure electrical or magnetic effects of Comet Halley, and attended the meeting of the International Solar Union in Pasadena. On his return to Britain he found that he had reached the summit of his profession: appointment as the ninth Astronomer Royal.[3] The Dysons returned to Greenwich for good.

Soon after taking the post he wrote, "It isn't all fun by any means. What between getting money from the Admiralty, satisfying the staff of various grades, and generally looking after 50 or 60 people, not to mention the genuine scientific work, there's plenty to do and a good deal of worry."

Such have always been the problems of administrators. By all accounts, Dyson was well suited to these tasks, and the Royal Observatory at Greenwich was most productive during his tenure. Unlike Campbell, Dyson was self-confident enough to leave his name off most of the publications produced by his staff. John Jackson, who served as one of his chief assistants, wrote of Dyson,

"He never exaggerated his case or presumed on the ignorance of others. When he had to ask for money for any project he never asked for more than what he himself was convinced was necessary. He was transparently honest. The result was that he probably sometimes got his way where a more forceful man might have failed...He was as willing to cooperate with those below him as above him in status or knowledge. To all members of the staff he gave great scope. He tried to interest all in the work they were doing and by his own enthusiasm imparted enthusiasm to others. It was by these methods that so much was accomplished while he held office at Greenwich."

One of the most important functions of the Observatory was the provision of time. At first every city kept its own time. Local noon was when the Sun crossed the meridian (the north-south-overhead line), and this was four minutes later for each degree of longitude westward. It was the railroads that insisted on standard time, and in 1880 Greenwich time was made legal for all of Great Britain (and Dublin time for Ireland. Time zones one hour apart came from the same 1884 conference which made Greenwich the prime meridian.) The Royal Observatory had been providing time service by telegraph since Airy's time. In 1924 Dyson began sending time signals directly to the B.B.C. for broadcast throughout the country. The famous "six pips" were broadcast at one second intervals, with the last one on the hour. (The magazine *Punch* noted that this enabled people to miss their morning trains by a smaller margin.)

Dyson adopted a new type of clock, invented by W.H. Shortt, which included a free "master" pendulum, which kept the time in a low-pressure, temperature-controlled case and did no work, and a second, "slave" pendulum, which was controlled by the master and which sent out the time signals automatically. Dyson liked to point out that the slave got to give the master a kick occasionally.

In 1911 Albert Einstein in Berlin published an early version of what would become the general theory of relativity, a

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2. Due to an error in transcription, Lockyer's name was misspelled in the article on Deslandres in the Jan/Feb 1993 issue of *Mercury*. — *Ed.*

3. The Astronomer Royal was the Director of the Royal Observatory until 1971. The Observatory was renamed the Royal *Greenwich* Observatory when it left Greenwich after World War II.

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totally new theory of gravity which gave results only slightly different from those of the Newtonian theory, and then only in locations where the gravitational field is very strong. Einstein predicted that starlight passing the limb of the Sun would be bent by about 0.87 arcseconds, a tiny effect that might be measurable on photographs of star fields surrounding the Sun during a total eclipse. German astrophysicist Erwin Freundlich set out to measure the bending of light, if any, at a 1914 eclipse in the Crimea. Fortunately for Einstein's scientific reputation, though not for Freundlich, the first World War intervened, and Freundlich was arrested and expelled from Russia.

The "Great War" caused enormous dislocations for everyone in Europe, including those at Greenwich. Dyson lost thirty-six members of his staff to the armed forces, and data reduction fell behind, even though he hired retirees, conscientious objectors, Belgian refugees, and women in their place. Eager to do a bit more for the war effort, Dyson and his staff collected, tested, and cleaned binoculars for the British forces, and the Dysons hosted garden parties at the observatory to raise money for the Red Cross.

In the middle of the war, in the capital of the enemy, Einstein published the final version of the general theory of relativity, now predicting a bending of light twice as great as in the earlier paper. Eddington, Dyson's former chief assistant at Greenwich and now a Cambridge professor, received the journals via neutral Holland and publicized the new theory in England. Meanwhile, Eddington's colleagues were anxious to get him a deferment from the draft, as the Quaker professor wanted to declare himself a conscientious objector, and the other professors believed such a declaration would embarrass the university. Dyson pointed out that the solar eclipse of 29 May 1919 would occur when the Sun was in the midst of the Hyades, offering no fewer than thirteen stars close enough to the Sun's limb and bright enough to photograph. It would be the best eclipse in a thousand years for measuring the Einstein effect.

The eclipse would occur in the South Atlantic Ocean, however, and there was no possibility of getting a ship unless the war ended before then. Nevertheless, Dyson persuaded the Admiralty to let him plan one expedition and to defer Eddington to plan another. As James Jeans described it, "In 1918, in the darkest days of the war, two expeditions were planned, one by Greenwich Observatory and one by Cambridge, to observe, if the state of civilisation should permit when the time came, the eclipse of May 1919 with a view to a crucial test of Einstein's generalised relativity. The Armistice was signed in November 1918; the expeditions went and returned, bringing back news which changed, and that irrevocably, the astronomer's conception of the nature of gravitation and the ordinary man's conception of the nature of the universe in which he lives."

Often remarking that science knows no frontiers, Dyson was active in furthering international cooperation in science and served as president of the International Astronomical Union. He nominated a German astronomer for the Bruce medal just four years after the war. He retired at 65 and spent his last years advising scientific organizations, co-authoring a book on eclipses, and visiting his eight children and numerous grandchildren. Like his predecessor, Christie, he died and was buried at sea. ■

Acknowledgement

The Dyson letter quoted is from the archives of the Royal Greenwich Observatory at the Cambridge University Library.