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Editorial

William Henry Bragg, man and scientist, Nobel Laureate and First Professor of Physics, University of Adelaide 1886–1909☆

ABSTRACT

In London, November 1915, a telegram was received at the home of William Henry Bragg from the secretary of the Academy of Science in Stockholm announcing the award of the Nobel Prize in Physics for "the analysis of crystal structures by means of X-rays". A second similar telegram was addressed to his 25 year old son William Lawrence Bragg (Jenkin, 2008). This article commemorates the centenary of that event and the unveiling of a bust of Sir William Bragg alongside that of his son, Sir Lawrence Bragg, on North Terrace in Adelaide where he spent 23 years of his early career.

1. Research beginnings

Professor William Bragg is one of the most distinguished professors ever to have been appointed to The University of Adelaide, and Sir Lawrence Bragg, one of its most distinguished graduates. This father and son research team discovered and developed X-ray crystallography, which revolutionised science and medicine. Yet William Bragg (Fig. 1) did not begin research until he was 42 years old, in Adelaide and with a young family.

A superb experimentalist and spokesperson for science, the Cambridge-educated William Bragg arrived in Adelaide in 1886, where he held the position of Elder Professor of Mathematics and Physics at the University until 1909. He learnt his experimental skills in Adelaide, to the point of apprenticing himself around 1887 to Sawtell's optical and watch making business in Rundle Street. While there, William recruited Arthur Rogers, his invaluable technical assistant.

Professor Bragg lectured and demonstrated X-rays and radio and began his research career in Adelaide in 1904. He received a visit from Ernest Rutherford in 1895 and another by Frederick Soddy in 1904. He read the scientific literature and was fascinated with, and thought deeply about, the new discoveries in modern physics, but remained a spectator until, as his daughter Gwendolen Caroe says in her biography, "It seemed.. fate gave him a push." [2]. William Bragg was called upon to give a presidential address to ANZAAS, the Australia and New Zealand Association for the Advancement of Science, and chose to speak about radioactivity. While reading a paper by Marie Curie, he realised that alpha particles must pass straight through the indivisible air atoms. He wrote, "This was contrary to all the teachings I knew. Still, it seemed to be right" [2]. William was given the funds to buy a small quantity of radium by a friendly philanthropist, Robert Barr Smith [1]. To investigate his theory he began his work on the ionisation and ranges of alpha particles from radium in air, for which he was awarded a Fellowship of the Royal Society in 1907, the first for the young University of Adelaide.

To perform the investigation, Professor Bragg designed, and Rogers constructed, a precision apparatus to measure alpha particle ranges using an ionisation chamber. As the range is only about 3 cm, precise readings were necessary. To quote Bragg, in the Caroe biography [2]:

> "I found that helium atoms of four different 'ranges', as I called them, were shot out from the radium preparation, which must belong to the four different active substances that Rutherford had shown to exist. Then I got a hint from Professor Soddy, who was passing through Adelaide, that I should dissolve the preparation in water, which would wash away three of the active substances but leave radium itself, the parent of them all. So I did, but horror of horrors, as I brought my measuring apparatus up towards the radium in the way I had learned to do, there was no radiation at all when I was well within the old range. However, with a very downcast spirit, I pushed the apparatus closer still, and suddenly a tremendous effect flashed out. The radium itself sent out particles of the shortest of the four ranges, not the longest as I had thought."

Other results came "tumbling out", including the Bragg ionisation curve and the well-known Bragg Peak, or ionisation maximum, near the end of the range. He wrote immediately to Rutherford at Montreal to tell him of his discoveries and despatched his first paper to the

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Fig. 1. WH Bragg in 1926 (Bassano portrait, State Library of S. A.)

Philosophical Magazine in London [3]. His letter started: "Dear Rutherford, I have lately obtained some curious experimental results in connection with the absorption of the α-rays which are, I think, new."

To quote Bragg again, "After that research was part of my daily life [2]." This work led directly to the offer of a professorship in England, and the family left Adelaide for Leeds, UK, in 1909. There he carried on a controversial correspondence with Charles Barkla and others about the nature of X-rays. In 1905, Barkla had discovered X-rays could be polarised [4]. Despite this, William thought they were particles. The issue was clarified by Max von Laue 's discovery, with Friedrich and Knipping, of X-ray diffraction in mid-1912 [5]. In 1917 Barkla received a Nobel Prize for discovering the characteristic X-ray lines utilised by the Braggs for their work.

In 1912, Bragg published a book "Studies in Radioactivity", MacMillan Press, with joint affiliations, University of Leeds and University of Adelaide. In ch 15, he developed an equation for gamma ray energy deposition in a small cavity in a larger medium. The equation was independently derived by L H Gray in 1936 and became the well known Bragg-Gray cavity theory, the basis of radiation dosimetry.

2. Early days in England

To fill in some background to the man William Bragg was, we now turn back to the early part of William's career. He was born in Cumberland, England, in 1862, to a farming family, well off enough to send him to King William's College on the Isle of Man, where he excelled academically in the new public examination system. This led him to Trinity College, Cambridge University and enrolment in the mathematics program in 1881. This culminated in the advanced and rigorous *Mathematical Tripos*, which included what we now call mathematical physics. William was surrounded by physics, but at the insistence of his tutor, focussed exclusively on mathematics for the final examination. He maintained his wellbeing by regular games of tennis and walking, but his social life was very lonely. He emerged as the third "wrangler" or third-highest honours student. William said later he regretted he had not attended other lectures and broadened his knowledge [2].

In his fourth year William made a deliberate decision to study experimental physics for the first time. This contradicts the popular story that he learnt his physics on the ship coming out to Australia, but he is known to have been excessively modest at this time. On graduation with an M.A. in mathematics, William Bragg worked in the Cavendish Laboratory for a year, attending lectures by J. J. Thomson, when an unexpected opportunity came up. Thomson suggested he apply for the professorship in mathematics and physics at the University of Adelaide. William had only 24 h to submit his application. He applied, not expecting to be chosen.

The appointment in Adelaide had been broadened to include physics when mathematics professor Horace Lamb, author of the well-known textbook *Hydrodynamics* written in Adelaide, returned to England. Clearly the University wanted more value from its new appointee, but it was a close thing. Of the small number of candidates, William Bragg got the appointment because the more experienced candidate had a propensity for the bottle and the appointment committee felt this would not go down well in conservative Adelaide, known as "the city of churches".

It turned out that the interview was conducted in London by the South Australian Agent General, Professor Lamb and Professor J. J. Thomson, but they also consulted the South Australian Postmaster General at the time, Charles Todd. Both the appointment and the link with Todd were to change profoundly the life of 24 year old William Bragg. It is interesting to see how the lives of Thomson, Todd and Bragg came closer together later on through marriage down the generations.

3. Adelaide, the early years

William disembarked at Glenelg in January 1886, at the same place where the first settlers and governor came ashore just 49 years earlier to found the "free" colony of South Australia and the city of Adelaide. He became one of five professors at the new University of Adelaide, with its handsome new Victorian gothic building on North Terrace. The colony had 130,000 inhabitants, most of whom lived in the country following agricultural and pastoral pursuits. The city had gas lighting, wide