

Bragging about Bragg

An Opinion Piece provided by
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Perhaps it's my imagination, but when I think back over my career, it seems almost as if there was a subliminal message directing me into crystallography from the earliest time. How often did I sit in Cossar Hall as an undergraduate at the Victorian College of Pharmacy, gazing at the extraordinary Sissons Mural¹ depicting science, medicine and pharmacy research? Every exam for my Pharmacy degree was held in that Hall, and I can assure you that desperate eyes were raised more than once to seek inspiration from the painting. Yet only recently did it click that right in the middle of the mural, an X-ray diffraction pattern is depicted in honour of the Braggs. Now, decades later, diffraction patterns are fundamental to my own research, and – although we never met – I have a direct scientific connection with Lawrence Bragg.

How did all this come about? After completing my Bachelor of Pharmacy degree and a Master of Pharmacy degree in computational chemistry/drug design, I was fortunate to be awarded an 1851 Scholarship² to study at the University of Oxford for a PhD (or D Phil as it's referred to there). I had elected to work with Peter Goodford, author of the program GRID, to develop skills in structure-based drug design. What I didn't realize before arriving in Oxford, was that the Laboratory of Molecular Biophysics (LMB) where Peter Goodford was based, was jam-packed with many of the world's most revered and decorated protein crystallographers. Professor David Phillips KBE FRS (later appointed to a life peerage as Lord Phillips of Ellesmere) headed the LMB. Furthermore, although long since retired, Nobel Laureate Professor Dorothy Hodgkin OM FRS still attended the occasional LMB research seminar. Heady stuff for a newly arrived Aussie girl from working-class origins.

Aside from designing inhibitors by structure-based methods, my research project involved soaking ligands into protein crystals and measuring diffraction data to investigate inhibitor binding modes. By another fortunate circumstance, the crystallography aspects of my D Phil research were supervised by an incredible role model, Louise Johnson (later FRS, Dame of the British Empire, and appointed as the David Phillips Professor of Molecular Biophysics in Oxford after Professor Phillips' retirement). Although I had not considered protein crystallography as a scientific career choice before, once immersed I was utterly obsessed by the precision, order and beauty of protein crystals and crystal structures. From that time on, crystallography has been the core methodology of my protein structure and drug design research.

¹ For more information, see www.pharm.monash.edu.au/faculty/sissons mural.html

² Full title, Royal Commission for the Exhibition of 1851 Science Research Scholarship.

Lately, there has been lighthearted banter at crystallography meetings, about generating a crystallography family tree, so that every crystallographer might trace their ancestry. Lucky me; I already know I'm a direct descendent of Lawrence Bragg. Louise Johnson was his last PhD student, making Lawrence Bragg my "crystallography grandfather".

The centenary of Lawrence Bragg's pivotal discovery is fast approaching, with celebrations proposed around the globe. In Dec 2012, the Asian Crystallography Association and the Society of Crystallographers in Australia and New Zealand are planning a Bragg symposium in Adelaide that is anticipated to feature (genetic) Bragg descendants, former Bragg PhD students, and other world-leading scientists. In 2013, the International Union of Crystallography will launch the International Year of Crystallography. For these commemorative years, the Australian Academy of Science National Committee for Crystallography, which I currently chair, have been lobbying various organizations to assist in raising the profile in Australia of Lawrence Bragg and the field of science he helped establish. Surprisingly, our petitions have on occasion met with refusals and comments like "the average Australian would not grasp the contributions made by Bragg". One might say the same about Einstein, yet his is a household name. What saddens me most about such ill-informed remarks is that there is plenty in the story of Lawrence Bragg to touch the hearts and minds of all Australians, if only we could get the message out.

In a tongue-in-cheek attempt to topple Einstein's $E = mc^2$ with Bragg's $n\lambda = 2d \sin \theta$, here follows a potted history of Lawrence Bragg, intended to highlight why every Australian can feel justly proud of him:

- Born in Adelaide on 31 March 1890, Lawrence Bragg was the grandson of Charles and Alice Todd. You may recognize those two names. Charles Todd was the architect of the famous overland telegraph between Adelaide and Darwin, and he and his wife Alice were well-loved members of the community. Their names are commemorated in the town of Alice Springs and the river Todd.
- Lawrence Bragg was the first Australian to win a Nobel Prize, being awarded the Physics Prize in 1915, six years before Einstein's 1921 Nobel Prize in Physics.
- Just 25 years old when the award was bestowed, Lawrence Bragg remains the youngest ever Nobel Laureate – a record that seems unlikely to be broken. For the record, Einstein was 42 in 1921.
- Lawrence and his father William H. Bragg³ were jointly awarded the Nobel Prize "*for their services in the analysis of crystal structure by means of X-rays*", and they remain the only father and son team to be awarded a Nobel Prize together. The inspired derivation of Bragg's law was actually the work of the 22-year old Lawrence. He and his father, a Professor in Physics at Leeds University, applied the equation to elucidate the first crystal structures, including those of sodium chloride and diamond.

³ William H. Bragg, an Englishman, had been Professor in Mathematics and Physics at the University of Adelaide; he lived in Adelaide for 23 years, from 1886 till 1909. There he met and married Gwendoline Todd (daughter of the aforementioned Charles and Alice) and together they raised a family of three children, the oldest being (William) Lawrence Bragg born in 1890. William H. Bragg is thought to have been one of the first in Australia to use X-rays in a medical application when in 1896, just 1 year after the discovery of X-rays by Röntgen, he took an X-ray photograph of 6-year old son Lawrence's broken elbow after a tricycle accident. In 1909, the Bragg family moved to the UK, where William H. Bragg had accepted an appointment as the Cavendish Chair in Physics at Leeds University. At the time, 18-year old Lawrence had already completed an undergraduate degree at the University of Adelaide. After arriving in the UK in 1909, Lawrence enrolled in a Mathematics degree at Cambridge, which he was awarded (Class I) in June 1912. Later that same year, his single author paper describing Bragg's law was published.

- Lawrence Bragg received the news of his Nobel award in Nov 1915 while he was posted on the Western Front in the Great War: he was then developing a method to pinpoint enemy artillery using sound-ranging. For this work he was later awarded the Military Cross and became an Officer of the Most Excellent Order of the British Empire.
- A few weeks before the Nobel Prize announcement, the Bragg family had received another communication. The news it contained and the effect on the family could not have been more different; it informed them that Lawrence's younger brother Bob had been killed at Gallipoli, aged 22.
- Bragg's law was truly groundbreaking and transformative. It unlocked the secrets of atomic structure and chemical bonding and established an entirely new field of science. This new field of crystallography has since revolutionized our understanding of chemistry, biology, physics, mineralogy, materials and medicine amongst others and has led directly to dozens of other Nobel prizes. The most recent of these was the 2009 Chemistry Nobel Prize to Ada Yonath⁴, Tom Steitz and Venki Ramakrishnan for the ribosome structure.
- Lawrence Bragg became the director of the Cavendish Laboratory in Cambridge where he fostered the careers of many other researchers including Nobel Prize winners Francis Crick and James Watson who decoded the structure of DNA, and Max Perutz and John Kendrew who solved the first protein structures, those of the body's oxygen carrying proteins haemoglobin and myoglobin. Later, as Director of the Royal Institution in London, he mentored other protein crystallography greats including David Phillips and Louise Johnson.

To my mind, Lawrence Bragg is the Bradman of Australian Science. His name should trip off the tongue as easily as Einstein when we discuss the world's greatest 20th century scientists. What a shame then, that most Australians are unaware of the triumphs of this incredible, brilliant man; of his Australian heritage; and of the legacy he left the world. I hope that in telling his story briefly here, you too will be inspired to spread the word so that in the upcoming commemorative years all Australians, like me, will be bragging about Bragg.

Acknowledgements

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Source References

nobelprize.org

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⁴ It's sobering to consider that Ada Yonath is only the fourth woman to be awarded a Nobel Prize in Chemistry, after Marie Curie in 1911, Irene Joliot-Curie in 1935 and Dorothy Hodgkin in 1964. Remarkably, of these four women Chemistry Nobel Laureates, two are crystallographers.