The Beginnings of X-ray Crystallography

A Profile on the Two Braggs

Those were the days when Science was hovering around the wave–particle duality. William Henry Bragg was toying with the idea that X-rays are particles and the observation made by Max von Laue that X-rays are diffracted by crystals could indeed lead to the understanding of crystal structures. On the other hand, his son, William Lawrence Bragg was confident that X-rays are waves and on November 11, 1912, read his paper at the *Cambridge Philosophical Society* which was published in 1913. Meanwhile, father Bragg constructed a new X-ray spectrometer after being convinced of his son's observation and the two collaborated to arrive at the seminal contribution of using X-rays to study the structure of crystals. The impact of this work heralded the beginning of X-ray crystallography and resulted in scientific achievements generating more than twenty Nobel Prizes over the last 100 years. So far, complete structures of a large number of crystals (over tens of thousands) spanning small molecules to large ones like proteins and viruses, have been defined. The two Braggs were jointly awarded the Nobel Prize in Physics in 1915 and son Bragg has remained the youngest Nobel awardee until the year 2014!

Father Bragg (2 July 1862–10 March 1942) was born at Westward near Wigton, Cumberland (Parents: Robert John Bragg, a merchant marine officer and farmer, and Mary (née Wood) – a clergyman's daughter). Bragg was appointed as the (Sir Thomas) Elder Professor of Mathematics and Experimental Physics at the University of Adelaide, Australia at the age of 23. Bragg's interest in electromagnetism had been triggered by Ernest Rutherford's visit in 1895. The most significant change in his career came in 1904 when he gave a talk at Dunedin on 'Some recent advances in the theory of the ionization of gases.' In collaboration with his student, Richard Kleeman, he published two path-breaking articles in the *Philosophical Magazine*: 'On the absorption of α rays and on the classification of the α rays from radium' and 'On the ionization curves of radium'.

The son Bragg (31 March 1890–1 July 1971) was born in North Adelaide, South Australia. He broke his arm when he was 5 years old and his father used the newly discovered Rontgen-rays (X-rays) and his experimental equipment to examine the broken arm, which is the first recorded surgical use of X-rays in Australia. William Lawrence Bragg married Alice Hopkinson (1899–1989) in 1921, with whom he had four children – Stephen Lawrence (born 1923), David William (born 1926), Margaret Alice (born 1931, who married Mark Heath) and Patience Mary (born 1935).

It is of interest to note that after receiving the Nobel Prize, the father and son team decided that they will work in different aspects of crystallography. W H Bragg decided to work on organic crystals while W L Bragg concentrated on crystals of metals and inorganic systems. Both of them encouraged women in Science. In particular, W H Bragg along with his student, J D Bernal, trained Dorothy Hodgkin (Nobel Laureate), Kathleen Lonsdale and Helen Megaw, all of whom made significant contributions to crystallography. A sheet, (*Figure* 1), off the notebook of W H Bragg gives a feel for the times in which initial X-ray diffraction data were interpreted in terms of the Bragg's law.

In his personal reminiscences, W L Bragg talks about his school days in Australia. He states, "I did not have an entirely happy time at school, though no fault of the school. I was no good at games, not for physical reasons but because I had not the right temperament, lacking the drive and self-assurance necessary to a good games player. Being rather advanced in my school work, I was a very young member of the sixth form, while at the same time making such a poor showing in games that I could only be put to play in the 'sets' with boys in much lower forms. Schoolboys only accept the normal boy into their full fellowship and, although they regarded me with kindly tolerance as a strange freak, I was very much cut off from my fellows, and driven into finding solitary interests of my own." It is noteworthy that Mike Glazer, who recently organized an

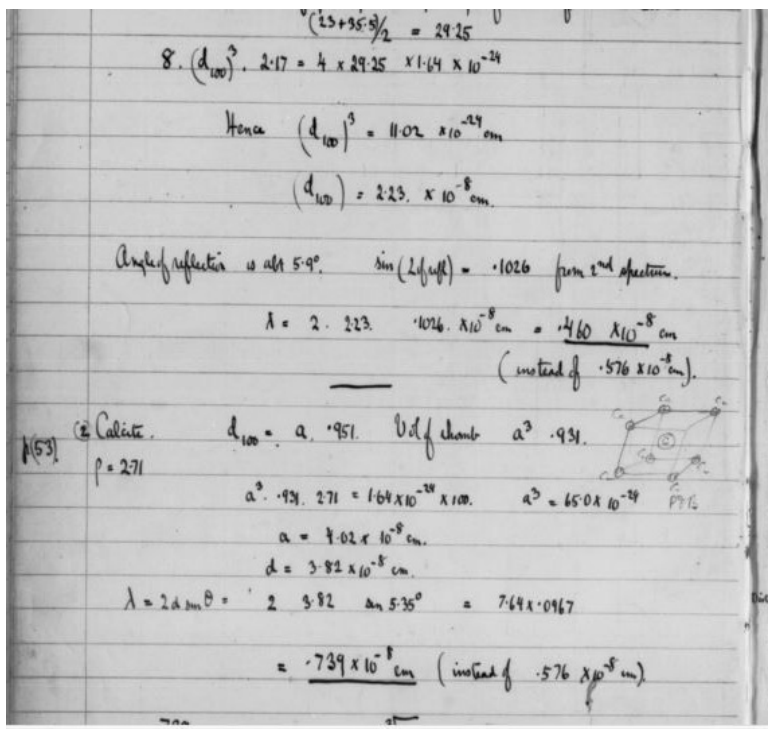

Figure 1.

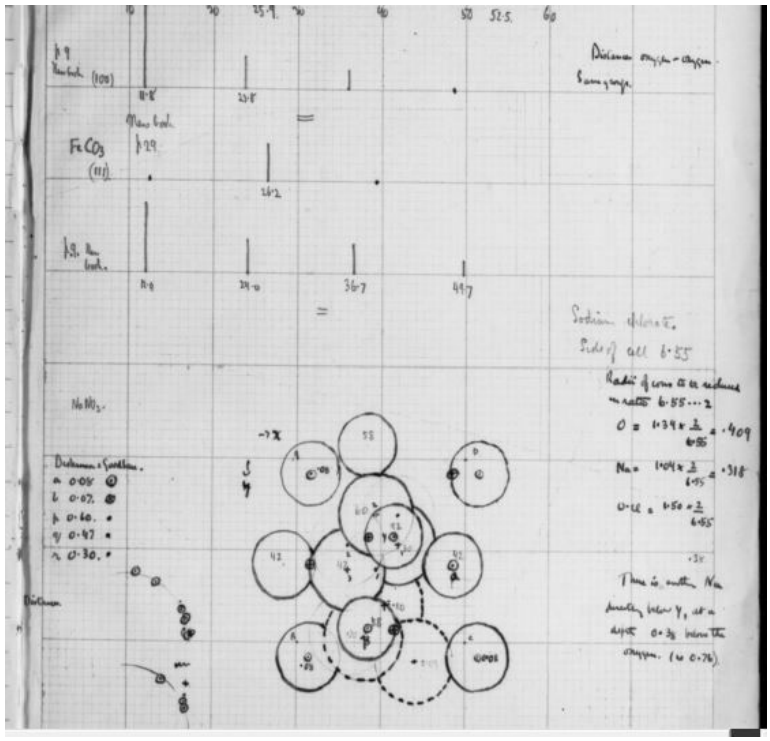

Figure 1. Continued.

exhibition celebrating the centenary of the work of the Braggs, remarks, "He particularly liked teaching science to children. It is considered that his schools' lectures were attended by upto 20,000 school students per year!", a fact which reflects his personality.

It is very appropriate that *Resonance* has decided to bring out this special issue as a tribute to the two Braggs on the occasion of the International Year of Crystallography . The discovery has revolutionized the approach in solid state science, and has made seminal contributions to materials and biological sciences as well.

Suggested Reading

[1] http://en.wikipedia.org/wiki/William_Henry_Bragg

[2] http://en.wikipedia.org/wiki/William_Lawrence_Bragg

[3] Mike Glazer, Celebrating Crystallography.

[4] Select Bibliography, http://library.leeds.ac.uk/resources/special-collections/bragg-notebook/bragg-notebook.pdf

T N Guru Row
Solid State and Structural Chemistry Unit
Indian Institute of Science, Bangalore 560 012, India.
Email: ssctng@sscu.iisc.ernet.in