

Women in crystallography

When compared with other areas of science (and especially physical sciences), crystallography was – from the beginning, at its foundation a century ago - unusually welcoming to women.

Crystallography still seems to have something much closer to gender balance in its teams than many other branches of physics and chemistry.

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To become a great scientist it is useful to have a compliant wife.

In December 1895 Wilhelm Konrad Röntgen took the first X-ray image of the left hand of his wife Bertha, showing the bones and a ring

This discovery marked the beginnings of modern crystallography and incidentally - the first contribution of women to this novel scientific discipline.

The Braggs: a welcoming environment

The Nobel Prize in Physics 1915 was awarded jointly to Sir William Henry Bragg and William Lawrence Bragg "for their services in the analysis of crystal structure by means of X-rays

The Braggs were very progressive in their views on women working as scientist.

They encouraged many to take up X-ray crystallography at a time when science was almost completely maledominated.

Both William and Lawrence Bragg trained numerous female students and researchers.



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The Pioneers: Kathleen Londsdale The first influential woman in crystallography was Kathleen Londsdale (1903-1971), a student of WH Bragg and colleague of J.D. Bernal

Kathleen Yardly was born in Ireland in 1903

- She was a good student, especially in mathematics and science. However, she had to attend classes in physics, chemistry and mathematics at the boys' high school because the girls' school idn't offer these subjects.
 She won a scholarship and was allowed to enter Bedford College for Women, part of the
- She won a scholarship and was allowed to enter Bedford College for Women, part of the University of London, at 16. She first read mathematics but at the end of her first year switched to physics (against the advice of her old headmistress).
- Kathleen came top in the University of London BSc examination in 1922, with the highest marks for 10 years. She was invited by WH Bragg, one of her examiners, to join his research school at University College, London (UCL).
- At UCL she met her husband, Thomas Lonsdale they got married in 1927 but he always encouraged her to continue her scientific work.

The Pioneers: Kathleen Londsdale

- She moved to Leeds (to follow her husband). Proved for the first time that the benzyl group, consisting of a ring of six carbon atoms, was flat rather than puckered.
- Moved back to London (again, to follow her husband). In the meantime had 3 kids -so for a few years worked from home, developing formulae for the space group tables, which became a milestone in the field (The International Tables for X-ray Crystallography)
 In 1931 Sir William Bragg wrote to her: "A piece of good news! Sir Robert Mond is giving me
- In 1931 Sir William Bragg wrote to her: "A piece of good news! Sir Robert Mond is giving me £200 with which you are to get assistance at home to enable you to come and work here. Can you come and see me soon?". This allowed her to move back into research at the Royal Institution with Bragg, where she stayed for 15 years.
- One of first two women to be elected as a Fellow of the Royal Society (1945)
- First female tenured professor at UCL (1949)
- First woman president of the International Union of Crystallography (1966)
- Committed pacifist (spent a month in jail for refusing to register for war duties and paying a $2\pounds$ fine); campaigned against nuclear testing.

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The Pioneers: Kathleen Londsdale

Kathleen Lonsdale strongly advocated greater participation of women in science – and their right to have both a career and a family.

She was very aware of the difficulties women encounter - in 1970 she said:

"Sir Lawrence Bragg once described the life of a university professor as similar to that of a queen bee, nurtured, tended and cared for because she has only one function in life. Nothing could be farther from the life lived by the average professional woman."

"Any country that wants to make full use of all its potential scientists and technologists could do so, but it must not expect to get the women quite so simply as it gets the men. It seems to me that marriage and motherhood are at least as socially important as military service. Government regulations are framed to ensure (in the United Kingdom) that a man returning to work from military service is not penalized by his absence. It is utopian, then, to suggest that any country that really wants married women to return to a scientific career, when her children no longer need her physical presence, should make special arrangements to encourage her to do so?".

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The Pioneers: Dorothy Hodgkin



Dorothy Hodgkin (1910-1994), a student of J.D. Bernal, was one of the founders of macromolecular crystallography.

- Dorothy Crowfoot was born in Cairo in 1910. Her father was an archaeologist as a young girl Dorothy helped with the excavation of Jerash, and was tempted to study Archaeology!
- Studied Chemistry in Oxford, then moved to Cambridge to work in crystallography with JD Bernal (a student of WH Bragg); then back to Oxford, where she determined the structure of Vitamin B12 and insulin
- She was the single winner the 1964 Chemistry Nobel prize. She was the third women laureate after Marie Curie e Irène Joliot-Curie – and the only British woman to have won.
- She married Thomas Hodgkin, a Marxist historian, working on the history of Africa and the Arab world (Dorothy received the news of the Nobel prize while in Ghana). They were both politicial activists and she helped a number of refugee scientists to come to the UK.

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The Pioneers: Rosalind Franklin

Rosalind Franklin (1920-1958) was a a student of J.D. Bernal

- · Born in London in 1920 from a wealthy Jewish family.
- Studied physical chemistry in Cambridge (against the will of her father, who wanted her to become a social worker), working on carbon and graphite microstructures
- In 1947 she started working on X-ray diffraction of graphite, in Paris
- In 1917 She started working on A ray annaction of graphice, in rai
- In 1950 she was hired at King's College, by J. Randall, to work on the structure of DNA together with Maurice Wilkins & PhD student Raymond Gosling
- In 1953 Rosalind left King's College, moved to JD Bernal's group and became a pioneer in structural virology, with excellent work on Tobacco Mosaic Virus and Poliovirus.
- Rosalind died of ovarian cancer at 37 in 1958. The Nobel prize was assigned in 1959, one year later.

Nobel 300 prize BRITISH dist. WOMAN WINS for -NOBEL PRIZE British wife £18,750 AWARD TO MOTHER A CABLE was sent yesterday to tell Professor Dorothy Crewfood Hodgkin, Oxford scientist and mother of three, that she has been awarded the 1964 Nobel prize for chemistry. It is worth more than £18.769. OF THREE 10

Nobel prize for a

wife from Oxford

The Pioneers: Dorothy Hodgkins

e UK newspape

When she got the Nobel prize, these

The Pioneers: Rosalind Franklin

The story that is often presented is that Crick and Watson stole the famous Picture 51 and pictured Rosalind as a "wronged heroine" – not quite true.

- In 1950 Rosalind Franklin was hired at King's College by J. Randall, to work on the structure of DNA together Maurice Wilkins & PhD student Raymond Gosling's project (without consulting them).
 Randall reassigned Raymond to Rosalind (again without telling Wilkins). Raymond R Rosalind collected many diffraction patterns, including the famous picture 51 of the B-form of DNA (collected by Raymond under Rosalind supervision), together with many other pictures of the A and B form of DNA. Rosalind openly presented the picture during a talk.
- Due to disagreements between, Randail assigned the A-form of DNA to Rosalind and the B-form to Maurice (this was supposed to favour Rosalind, as it was more ordered).
 The Kinos (Wilkins & Rosalind) and Cambridge (Watson & Crick) amus often talked and shared data
- The Kings (Wilkins & Rosalind) and Cambridge (Watson & Crick) groups often talked and shared data: Maurice showed the picture to Jim Watson, but also Max Perutz had received a report from Kings with Rosalind data and interpretation.
- Photograph 51 was an important piece of data, but was not "the philosopher's stone" of the double helix structure – it provided some geometric parameters against which to test structures obtained by modelling

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The Pioneers: Rosalind Franklin

So, where does the popular version of the story – with Rosalind as the victim – originated?

Watson tells the story as if Photo 51 was the key to the secret of life -



whereas Rosalind sat on if for months, also key to the sected in the immediately understood ("my mouth fell open and my pulse began to race"). He also stereotyped Franklin as a frumpy, unattractive intellectual. commer (36,647200) What Rosalind Franklin truly contributed to the discovery of DNA's structure

A recent comment on Nature reveals further documents that show she was an equal player, and aware of what was going on at Cambridge (this is in line with what I heard multiple time by witnesses).

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The Pioneers: Rosalind Franklin



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- Rosalind Franklin left Kings but was in good terms with most of the Cambridge crowd
- She was highly respected as an excellent scientists – and an equal contributor to the discovery
- contributor to the discovery
 She became good friend with Odile Crick (Francis' wife)

Anne Cullis, Francis Crick, Donald Caspar, Aaron Klug, Rosalind Franklin, Odile Crick and John Kendrew at the **1956 International Union of** Crystallography meeting in Madrid, Spain

The Pioneers: Rosalind Franklin

HOWEVER things are not black and white:

- · Rosalind was certainly the victim misogyny (and possibly antisemitism)
- Kings college was an unwelcoming environment (for example women were not accepted in the senior common room)
- There was certainly an element of competition: mostly with Linus Pauling, but also
 partly between King's College and the Cavendish Laboratory at Cambridge (although
 there was a degree of communication and a joint desire to beat Pauling)
- Crick, Watson and Wilkins did not nominate her and stress her contribution during their Nobel speech

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"By choice she did not emphasize her feminine qualities. Though her features were strong, she was not unattractive and might have been quite stunning had she taken even a mild interest in clothes. This she did not. There was never lipstick... her dresses showed all the imagination of English bluestocking adolescents... it was quite easy to imagine her the product of an unsatisfied mother who nuduly stressed the desirability of professional careers that could save bright girls from marriages to dull men."

"Clearly Rosy had to go or be put in her place. The former was obviously preferable because, given her belligerent moods, it would be very diffcult for Maurice to maintain a dominant position that would allow him to think unhindered about DNA... Unfortunately, Maurice couldn't see any decent way to give Rosie the boot. To start with, she had been given to think that she had the position for several years. Also, there was no denying that she had a good brain. If she could only keep her emotions under control, there would be a good chance she could really help him."

James Watson, the Double Helix

"She was a pretty tough person: single-minded, spoke what she believed and could, in fact, be quite fierce. And if she had been a man, it would have gone totally unremarked." Aaron Klug

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Why?

- Crystallography was a brand new field, less prone to prejudices?
- The Braggs' record of employing women chemists illustrates that environment and encouragement are important in women's participation. The crucial contribution that a few brilliant women made to crystallography in the .
- very early days
- This "good" start has created a positive feedback mechanisms, by providing a number of female role models
- In the early days this includes a number of examples when women (and men!) would bring their kids to the lab or to conferences .
- Crystallography at the time was incredibly hard you needed to SHARE data, information, computer programmes... this created a very collaborative ethos and a less competitive culture, which may be responsible for a more welcoming environment, to women, but also to scientists coming from many part of the world. .

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