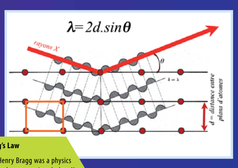
Using X-rays to explore the structure of crystals

After the Laue experiment, which revealed that, because of their periodicity, crystals could cause X-rays to diffract, William Lawrence Bragg and his father, William Henry Bragg, developed the science of X-ray crystallography. This enabled them to determine the atomic structure of the crystal.



Bragg's Law

William Henry Bragg was a physics professor and was convinced that X-rays were particles identical to electrons, but with no electrical charge. He understood that the findings of Laue's experiment supported the idea of X-rays as light (or waves). Bragg's son William Lawrence was only 22 at the time and a fervent supporter of his father's ideas. It was when trying to prove them that he formulated Bragg's law λ=2dsinθ, linking the deviation of the x-ray beam to the distance between the planes formed by the atoms.

William Lawrence Bragg (son)

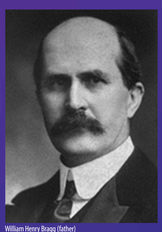
λ=2dsinθ

In 1912, the Braggs analysed Laue's results in detail. At 22 years of age William Lawrence worked out an equation for calculating the position of the atoms within a crystal from the manner in which the surface planes of this crystalline structure diffract the X-rays:
Bragg's Law λ=2dsinθ.

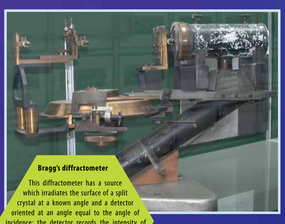
Delving deeper into the heart of the crystal

By as early as 1912 the Braggs had invented a new apparatus: the X-ray diffractometer (spectrometer). They took numerous measurements with their diffractometer and investigated the atomic structure of different crystals.
The Braggs received the Nobel prize for physics in 1915

The diffraction of X-rays was no longer a mere physical phenomenon; it had become a tool for exploring the arrangement of atoms within the crystals.



William Henry Bragg (father)



Bragg's diffractometer

This diffractometer has a source which irradiates the surface of a split crystal at a known angle and a detector oriented at an angle equal to the angle of incidence; the detector records the intensity of the diffracted beams. The instrument has a gas detector and can directly measure the diffracted intensity as a function of the diffraction angle.

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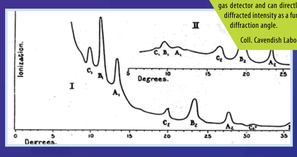
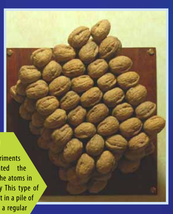
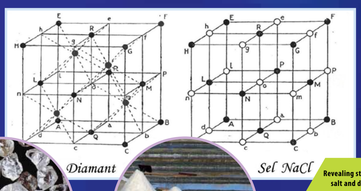


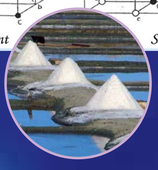


A walnut crystal!

The diffraction experiments with X-rays highlighted the regularity in the order of the atoms in crystals, i.e. their periodicity This type of order can be likened to that in a pile of walnuts at the grocer's - a regular periodic stack.

Coll. Institut Néel





Revealing structures of salt and diamonds

Bragg and son performed dozens of measurements with their diffractometer and determined the atomic structure of many crystals, including those of common salt NaCl and the less common diamond (composed uniquely of carbon atoms).